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DRAFT
ASH IMPOUNDMENT CLOSURE
ENVIRONMENTAL IMPACT STATEMENT

PART I – PROGRAMMATIC NEPA REVIEW

Prepared by:
TENNESSEE VALLEY AUTHORITY
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Symbols, Acronyms, and Abbreviations

~	Approximately
>	Greater Than
<	Less Than
µm	Micrometers
ADEM	Alabama Department of Environmental Management
ALF	Allen Fossil Plant
APE	Area of Potential Effect
BMP	Best Management Practices
BNSF	Burlington Northern and Santa Fe Railway
BRF	Bull Run Fossil Plant
CAA	Clean Air Act
CCR	Coal Combustion Residuals
CCW	Condenser Cooling Water
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CH_4	Methane
cm/sec	Centimeters per Second
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_3	Carbonate
COC	Constituents of Concern
COF	Colbert Fossil Plant
CSX	CSX Transportation, Inc.
CUF	Cumberland Fossil Plant
CWA	Clean Water Act
dB	Decibel
dBA	A-weighted decibel
DDT	Dichlorodiphenyltrichloroethane
EF	Engineered Fill
EIS	Environmental Impact Statement
EF	Engineered Fill
EJ	Environmental Justice
EO	Executive Order
EPA	U.S. Environmental Protection Agency
EPRI	Electric Power Research Institute
ESA	Endangered Species Act of 1973
ETSZ	East Tennessee Seismic Zone
FGD	Flue Gas Desulfurization
g	Gravitational Pull
GAF	Gallatin Fossil Plant
GHG	Green House Gas
GRM	Green River Mile
HAP	Hazardous Air Pollutants
HFC	Hydrofluorocarbons
HUD	U.S. Department of Housing and Urban Development
Hz	Hertz
JOF	Johnsonville Fossil Plant
JSF	John Sevier Fossil Plant
KDEP	Kentucky Department of Environmental Protection
KIF	Kingston Fossil Plant
Ldn	Day-Night Sound Level
Leq	Equivalent Sound Level

MGD	Million Gallons Per Day
mg/l	Milligrams Per Liter
mi^2	Square Miles
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMSZ	New Madrid Seismic Zone
N_2O	Nitrous Oxide
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
OSHA	Occupational Safety and Health Act
PAF	Paradise Fossil Plant
PCB	Polychlorinated Biphenyl
PEIS	Programmatic Environmental Impact Statement
PFC	Perfluorocarbon
PGA	Peak Ground Acceleration
PPK	Projectile Points/Knives
ppb	Parts Per Billion
PM	Particulate Matter
$PM_{2.5}$	Particulate Matter less than 2.5 µm
PM_{10}	Particulate Matter less than 10 µm
ppb	Parts Per Billion
PSA	Power Service Area
RCRA	Resource Conservation and Recovery Act
RERC	Regional Energy Resource Council
RRSC	Revised Regional Stewardship Council
SHF	Shawnee Fossil Plant
SHPO	State Historic Preservation Officer
SO_2	Sulfur Dioxide
TDEC	Tennessee Department of Environment and Conservation
TSDF	Treatment, Storage and Disposal
TSS	Total Suspended Solids
TVA	Tennessee Valley Authority
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCB	U.S. Census Bureau
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	Volatile Organic Compound
VSMP	Vital Signs Monitoring Program
WCF	Widows Creek Fossil Plant
yd^3	Cubic Yards

CHAPTER 1 – PURPOSE AND NEED FOR ACTION

1.1 Introduction

The Tennessee Valley Authority (TVA) has prepared this Programmatic Environmental Impact Statement (PEIS) to address the closure of coal combustion residual (CCR) impoundments at its coal-fired power plants (Figure 1-1). The purpose of the PEIS is to assist TVA in complying with the CCR Rule issued by the United States Environmental Protection Agency (EPA) on April 17, 2015 (80 Federal Register 21302). CCRs are byproducts produced from burning coal and include fly ash, bottom ash, boiler slag, and flue gas desulfurization materials. In 2009, TVA also outlined a plan to eliminate wet storage of CCRs at its plants and convert all wet fly ash, bottom ash, and gypsum operations to dry storage. This PEIS evaluates those impoundment closure actions that are consistent with TVA's overall plan to eliminate wet storage of CCRs at its facilities.

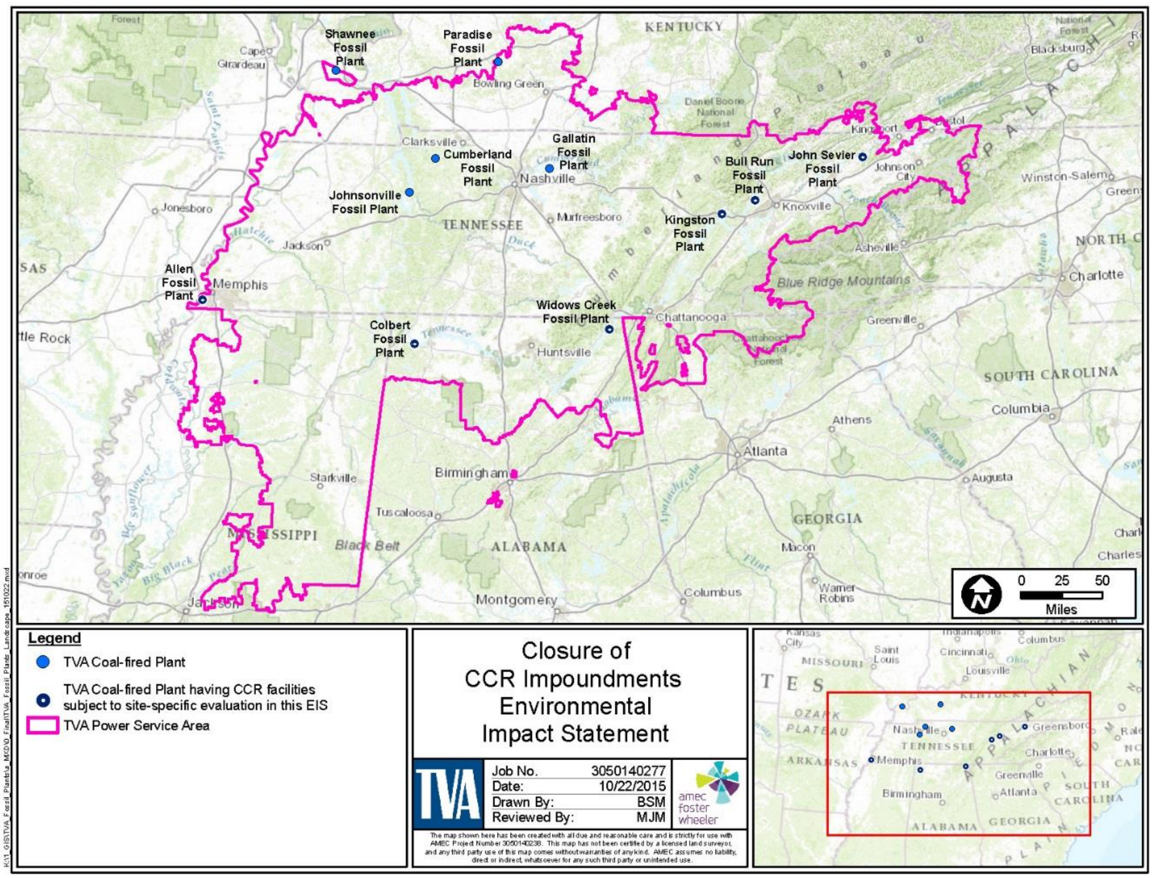

Figure 1-1. TVA Coal-Fired Power Plants

Historically, TVA has managed storage of CCR materials in ash impoundments or dry landfills. After the dike failure and ash spill at the Kingston Fossil Plant in 2008, TVA's Board of Directors directed TVA staff to review and address systems, controls, and standards related to CCRs. The outcome of that review was the plan to convert wet storage of CCRs to dry storage and close ash impoundments. This is being done on a project by project basis, subject to the technical feasibility, availability of resources and environmental review.

CLASSES OF ASH IMPOUNDMENTS Under EPA's CCR Rule:

Inactive Impoundment: An inactive surface impoundment is defined as a CCR surface impoundment that no longer receives CCR on or after October 19, 2015 and still contains **both** (emphasis added) CCR and liquids on or after October 19, 2015 (EPA 2015, § 257.53).

Active Impoundment: An active impoundment receives CCR on or after October 19, 2015.

Closed Impoundment: A closed impoundment no longer contains water though it may contain CCR and would be capped or otherwise maintained.

On April 17, 2015, the EPA established national criteria and schedules for the management and closure of CCR facilities (80 Federal Register 21302) (herein referred to as the CCR Rule). Table 1-1 provides a schedule of key regulatory milestones associated with both inactive impoundments (those not receiving CCR after October 19, 2015) and active ash impoundments. Figure 1-2 provides a conceptual framework for consideration of ash impoundment closure. In the preamble to the CCR Rule, EPA asserted that if done properly either Closure-in-Place or Closure-by-Removal would be equally protective of human health and the environment. EPA observed that most facilities would be closed in place because of the difficulty of removing CCRs and costs. EPA purposefully structured its CCR Rule to encourage regulated entities to accelerate the closure of CCR impoundments because of the decrease in groundwater risk and increased structural stability that results from eliminating the downward hydraulic pressures of ponded water. These pressures are often referred to as "hydraulic head" which is defined as the force exerted by a column of liquid expressed by the height of the liquid above the point at which the pressure is measured.

TVA has coal-combustion power plants and ash impoundments in Alabama, Kentucky, and Tennessee (Figure 1-1 and Table 1-2).

The ash impoundments within TVA's system vary in size, and are represented by those that are less than 10 acres (ac) to those that are nearly 400 ac. Many of the existing ash impoundments are decades old, and the larger impoundments contain millions of cubic yards (yd^3) of CCR material. As part of this PEIS, TVA is evaluating impacts of closing inactive and active impoundments as well as other impoundments that are not subject to the CCR Rule (e.g., plant is no longer generating power or CCR but still has storage basins that have not been closed to final grade).

Illustration of "Hydraulic Head" Concept

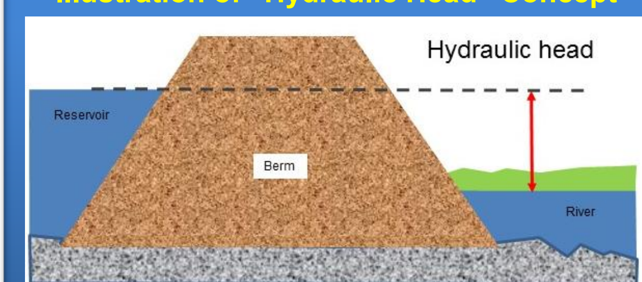

Table 1-1. CCR Rule Regulatory Timeframe

Activity	Regulatory Timeframe
Inactive CCR Impoundment	
"Inactive CCR Impoundment" – No longer receives CCR but may contain both CCR and liquids (§ 257.53)	October 19, 2015
Closure Notice (§ 257.100) Progress Reports	December 17, 2015 Annually
Complete Closure (exempt from additional CCR operating, monitoring, and post-closure requirements)	April 17, 2018
Existing Active CCR Impoundment	
Location Restrictions (§§ 257.60 – 257.64)	October 17, 2018
Design Criteria (§ 257.71)	October 17, 2016
Structural Integrity (§ 257.73) • Identification marker • Structural stability assessment	 December 17, 2015 October 17, 2016
Air Criteria (§ 257.80) Fugitive Dust Control Plan	October 19, 2015
Hydrologic and Hydraulic Capacity (§ 257.82)	October 17, 2016
Inspections (§ 257.83 (a))	October 19, 2015
Groundwater Monitoring (§ 257.90) • Corrective Action – assessment of corrective measures	October 17, 2017 Initiate assessment within 90 days of finding an exceedance or immediately if a release is detected. Implement corrective action within 90 days of selecting a remedy.
Closure (§ 257.101)	After October 19, 2015
Recordkeeping, Notification, and Internet Requirements (§§ 257.105 – 257.107)	October 19, 2015
Later CCR Impoundment/Ash Impoundment Closure	
If cannot meet groundwater protection standards, location restriction, or safety assessment requirements, cease receipt of CCR	Within 6 months
Close impoundment	Within 5 years
Closure extension for factor's beyond a facility's control	< 40 ac in size = 2-year extension > 40 ac in size = up to five 2-year extensions
Post-Closure Care (§ 257.104)	30 years after closure

Source: EPA 2015

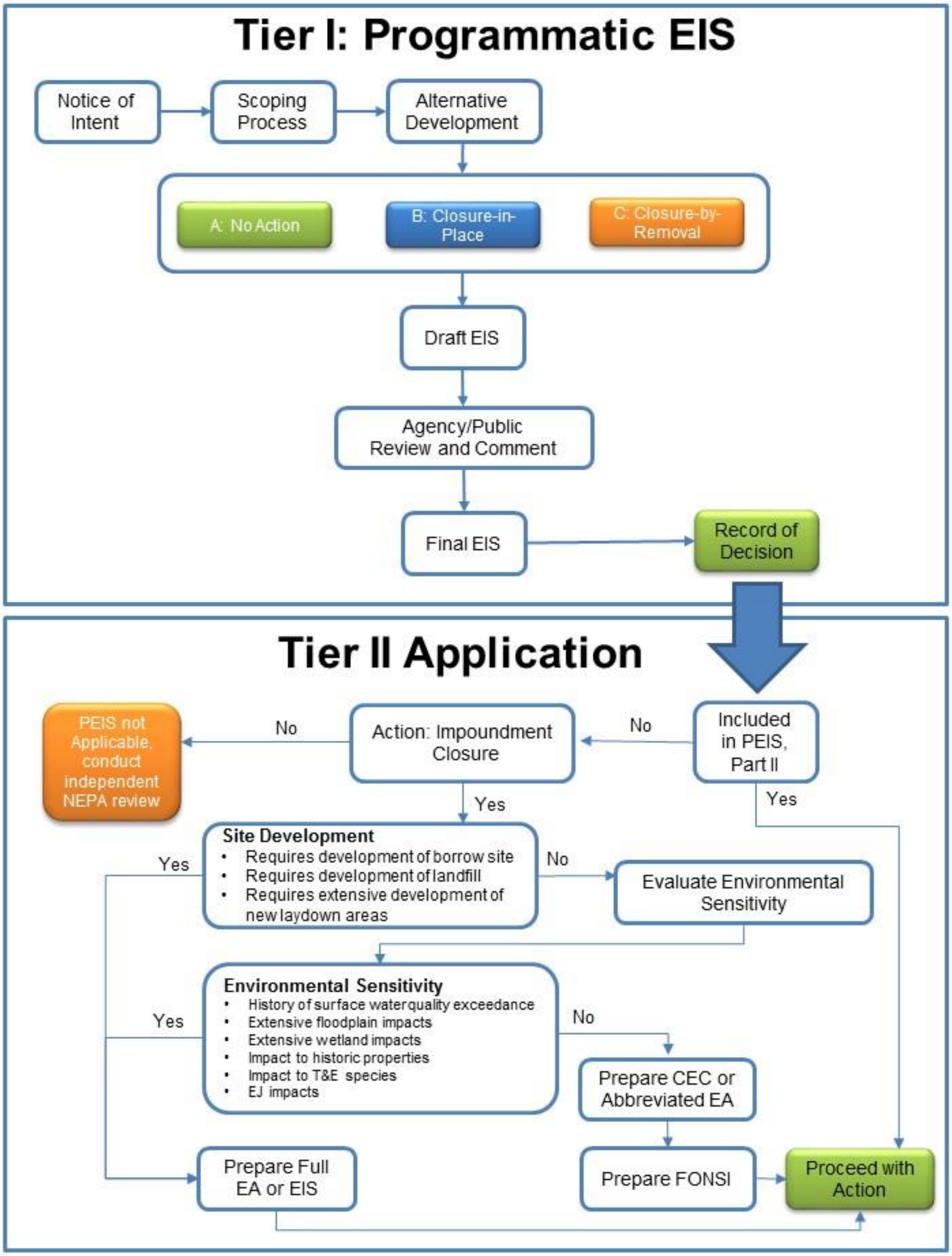

Figure 1-2. Tiered NEPA Process for TVA Ash Impoundment Closure

Table 1-2. TVA Fleet-wide Coal-Fired Power Plants

Plant	Location	Plant Status	Number of Ash Impoundments	Ash Impoundment Status	CCR Material
Allen Fossil Plant (ALF)	Shelby County, Tennessee	Three coal-fired units to retire once CC facility is active.	2	Inactive-1 Active-1	Fly ash and boiler slag
Bull Run Fossil Plant (BRF)	Clinton, Anderson County, Tennessee	Active	2	Inactive	Bottom ash, and fly ash
Colbert Fossil Plant (COF)	Tuscumbia, Colbert County, Alabama.	Fossil plant expected to close in April 2016	1	Active	Bottom ash and fly ash
Cumberland Fossil Plant (CUF)	Cumberland City, Houston County, Tennessee	Active	2	Active	Bottom ash and gypsum
Gallatin Fossil Plant (GAF)	Gallatin, Sumner County, Tennessee	Active	4	Active	Bottom ash and fly ash
John Sevier Fossil Plant (JSF)	Rogersville, Hawkins County, Tennessee	Inactive	1	Active	Bottom ash
Johnsonville Fossil Plant (JOF)	New Johnsonville, Humphreys County, Tennessee,	Retired by December 31, 2017	1	Active	Bottom ash and fly ash
Kingston Fossil Plant (KIF)	Harriman, Roane County, Tennessee	Active	2	Inactive	Bottom ash and fly ash
Paradise Fossil Plant (PAF)	Drakesboro, Muhlenberg County, Kentucky	Active	3	Active	Boiler slag, gypsum and fly ash
Shawnee Station Fossil Plant (SHF)	Paducah, McCracken County, Kentucky	Active	1	Active	Bottom ash
Widows Creek Fossil Plant (WCF)	Stevenson, Jackson County, Alabama	Retired by October 15, 2015	3	Inactive	Bottom ash, fly ash and gypsum

This National Environmental Policy Act (NEPA) document is organized in two parts:

> **Part I:** A Tier I PEIS that addresses the closure of CCR impoundments at its coal-combustion power plants as illustrated in Figure 1-2. Conclusions reached from such a programmatic analysis generally should be applicable to any CCR ash impoundment in the TVA system.
>
> **Part II:** An integrated analysis of ten site-specific ash impoundment closures at each of six generating stations within TVA's system of coal-combustion power plants. These coal-combustion power plants include Allen (ALF), Bull Run (BRF), Kingston (KIF), and John Sevier (JSF) in Tennessee and Widows Creek (WCF) and Colbert (COF) in Alabama. Part II consists of a tiered analysis that integrates the findings and conclusion of the Tier I document.

The PEIS programmatically considers all TVA ash impoundment closures and the environmental effects of two primary ash impoundment closure methods: (1) Closure-in-Place; and (2) Closure-by-Removal.

This PEIS was developed in accordance with NEPA; 42 United States Code (USC) §§ 4321 et seq.; Council on Environmental Quality (CEQ) regulations for implementing NEPA, 40 Code of Federal Regulations (CFR) Parts 1500-1508; and TVA's procedures for implementing NEPA.

1.2 Purpose and Need

During 2013, TVA produced approximately 4.2 million tons of CCRs, with approximately half being synthetic gypsum and 33 percent being fly ash (Table 1-3). Of the 4.2 million tons, 0.9 million tons or 21 percent were utilized or marketed, which is a decrease from the 2.8 million ton annual average for 2006–2008, mostly due to reduced demand resulting from the recent recession. In 2014, the beneficial reuse rate of CCRs increased to 29 percent. The main beneficial uses of CCRs are in the manufacture of wallboard, roofing, cement, concrete and other products (TVA 2015).

The CCRs that are not beneficially reused are currently stored in landfills and impoundments at or near coal plant sites. The need is to effectively and efficiently manage CCR in a manner that is protective of human health and the environment.

Following the dike failure and ash spill at KIF in December 2008, TVA committed to assessing the stability of its impoundments and converting its coal-combustion power plants to dry CCR storage. TVA has been implementing long-term stability improvements at impoundments to reduce the potential consequences of structural failures and risk to surface and groundwater from CCR releases. It has also committed to closing its wet CCR impoundments. The remaining conversion to dry CCR storage projects are expected to be completed in four to six years (TVA 2015).

Table 1-3. CCRs Generated by TVA from 2010-2013

	Production (tons)		Utilization (Percent)	
CCR Material*	**2010-2012 Average**	**2013**	**2010-2012 Average**	**2013**
Fly Ash	1,798,352	1,389,857	18.8%	30.1%
Bottom Ash	356,975	288,543	0.2%	0.0%
Boiler Slag	482,986	409,385	63.9%	71.0%
Synthetic Gypsum	2,406,276	2,150,356	23.3%	22.6%
Total	5,044,589	4,238,141	17.7%	20.6%

* Does not include Char and Spent Bed Material that are no longer produced at TVA facilities.

Source: TVA 2015

In April 2015, the U.S. Environmental Protection Agency (EPA) established national criteria and schedules for the management and closure of CCR facilities. EPA purposefully structured its CCR Rule to encourage regulated entities to accelerate the closure of CCR impoundments because of the decrease in groundwater risk and increased structural stability that results from eliminating the hydraulic head of ponded water. TVA identified impoundments to close prior to the April 17, 2018 deadline.

The purpose of this PEIS is to address the potential impacts of closing CCR impoundments across the TVA system and to assist TVA in complying with EPA's CCR Rule.

1.3 Related Environmental Reviews and Consultation Requirements

TVA previously conducted the following environmental reviews, which are relevant to this PEIS concerning ash management:

- Development of Ash Management Strategy Allen Fossil Plant, Final Environmental Assessment, 2006
- Allen Fossil Plant Emission Control Project, Final Environmental Assessment, 2014
- Kingston Dry Fly Ash Conversion Final Environmental Assessment, 2010
- Kingston Fossil Plant Bottom Ash Dewatering Facility Draft Environmental Assessment, 2015
- Bottom Ash and Gypsum Mechanical Dewatering Facility Bull Run Fossil Plant Final Environmental Assessment, 2012
- Widows Creek Fossil Plant Gypsum Removal Project Final Environmental Assessment, 2009
- Installation of Emission Control-Equipment and Associated Facilities at Gallatin Fossil Plan Final Environmental Assessment, 2012
- Johnsonville Fossil Plant Ash Pond Dike Stabilization Environmental Assessment, 2010

1.4 Decision to be Made

TVA must decide how to close its wet CCR impoundments. TVA has committed to managing all of its future CCR production in dry storage landfills, closing its existing wet

CCR impoundments, and complying with the CCR Rule. TVA's decision will consider factors such as environmental impacts, economic issues, availability of resources, and TVA's long-term goals.

1.5 Identification of the Project Scope

The geographic scope of this programmatic analysis includes the TVA region as identified in Section 1.1, specifically the 11 counties within the TVA region where TVA's coal-fired power plants are located. Additional information regarding each of the ten CCR impoundments considered in Part II (proposed to be closed by April 17, 2018) is summarized in Table 1-4.

Table 1-4. Summary of CCR Impoundments Evaluated in Part II

Plant	Site	Size	Primary CCR Type	CCR Volume (yd^3)
ALF (Cyclone)[1]	West Impoundment	22 ac	Fly ash and boiler slag	250,000
BRF(Pulverized Coal)	Sluice Channel	5.5 ac	Bottom ash	27,000
BRF (Pulverized Coal)	Fly Ash Impoundment	33 ac	Fly ash	3,500,000
COF (Pulverized Coal)	Ash Impoundment 4	52 ac	Bottom ash and fly ash	3,200,000
JSF (Pulverized Coal)	Bottom Ash Impoundment	42 ac	Bottom ash and fly ash	145,500
KIF (Pulverized Coal)	Stilling Impoundment	25 ac	Bottom ash and fly ash	700,000
KIF (Pulverized Coal)	Sluice Trench	6 ac	Bottom ash	10,000
WCF (Pulverized Coal)	Main Ash Impoundment Dredge Cell Upper and Lower Ash Stilling Impoundments	350 ac (110 ac in Dredge Cell and 240 ac in other impoundments)	Bottom ash, fly ash, and gypsum	25,000,000

[1] Cyclone units produce slag and pulverized coal units produce bottom ash.

TVA prepared this PEIS in compliance with NEPA, regulations promulgated by the CEQ and TVA's procedures for implementing NEPA. TVA has determined that the resources listed below are potentially impacted by the alternatives considered. These resources were identified based on internal scoping as well as comments received during the public scoping period.

- Air Quality
- Climate Change
- Land Use
- Prime Farmland
- Geology and Seismology
- Groundwater
- Surface Water
- Floodplains
- Vegetation
- Wildlife
- Aquatic Ecology
- Threatened and Endangered Species
- Wetlands
- Socioeconomics and Environmental Justice
- Natural Areas, Parks and Recreation
- Transportation
- Visual Resources
- Cultural and Historic Resources
- Noise
- Solid Waste and Hazardous Waste
- Public Health and Safety

TVA's action will satisfy the requirements of Executive Order (EO) 11988 (Floodplains Management), EO 11990 (Protection of Wetlands), EO 12898 (Environmental Justice), EO 13112 (Invasive Species), and EO 13653 (Preparing the United States for the Impacts of Climate Change); and applicable laws including the National Historic Preservation Act of 1966 (NHPA), Endangered Species Act of 1973 (ESA), Clean Water Act (CWA) and Clean Air Act (CAA).

1.6 Summary of Public and Agency Coordination Process

During the scoping period for the PEIS, TVA published a Notice of Intent (NOI); sent notifications to a broad range of federal, state, and local agencies; established a PEIS Web site; and provided a number of means for the public to provide comments verbally, in writing, and by phone message.

TVA's public and agency involvement for the Draft PEIS includes a public notice and a 45-day public review of the Draft PEIS. To solicit public input, the availability of the Draft PEIS was announced in regional and local newspapers. A news release was issued to the media and posted to TVA's Web site. The document was posted on TVA's Web site and hard copies were made available by request. TVA's agency involvement includes circulation of the Draft PEIS to local, state, and federal agencies and federally recognized tribes as part of the review. A list of agencies and tribes notified of the availability of this draft PEIS is provided in Chapter 6.

During the public comment period on the Draft PEIS, TVA expects to conduct 10 public meetings at fossil plants across the Valley. TVA has also provided information about the PEIS and the associated public comment periods to TVA's Federal Advisory Committee Act (FACA) groups, the Regional Energy Resource Council (RERC) and the Regional Resource Stewardship Council (RRSC).

Once the public and other agencies have reviewed the document, TVA will make revisions, if necessary, and issue a Final PEIS. TVA will not make final decisions any earlier than 30 days after the Notice of Availability of the Final PEIS is published in the Federal Register.

1.6.1 Notice of Intent

On August 27, 2015, TVA published the NOI in the Federal Register announcing that it planned to prepare an EIS to address the closure of CCR impoundments at its coal-fired power plants. The NOI initiated a 30-day public scoping period, which concluded on September 30, 2015. In addition to the NOI in the Federal Register, TVA published notices regarding this effort in regional and local newspapers; issued a news release to media; and posted the news release on the TVA Web site to solicit public input.

1.6.2 TVA's Project Web Site

TVA established a Web site https://www.tva.gov/environment/reports/ccr as a platform for additional public outreach. It is intended for use as a central location for distributing information to the public. The project Web site includes:

- A summary of the project
- The Project NOI
- The Draft PEIS
- Contact information for the TVA project lead

- Presentation materials that TVA provided at the public meetings.

In addition to the ability to submit written comments, TVA provided the public two web-based means to submit comments during the scoping period. An email address was provided which the public could submit comments or questions. The email address (ccr@tva.gov) will be used throughout the duration of the project. Second, a web-based comment submittal form was available to the public during the scoping period, as part of TVA's Comment Management Web site. This form was available to the public during the scoping period and will be available during the comment period on the Draft PEIS.

1.7 Required Permits and Licenses

Depending on the decisions made respecting the proposed actions, TVA may need to obtain or seek amendments to the following permits:

- National Pollutant Discharge Elimination System (NPDES) permit for storm water runoff from construction activities.
- Modification of existing NPDES permits due to dewatering or outfall location changes to discharges.
- Actions involving wetlands and/or stream crossings will be subject to federal CWA Section 404 permit requirements as well as state Section 401 water quality certification.
- Section 408 Rivers and Harbors Act by the U.S. Army Corps of Engineers (USACE) for actions involving work near levees.
- Submittal of closure plans to the respective state agency with a closure design that meets state solid waste regulations and CCR Rule requirements.
- Submittal of Groundwater Monitoring Plan for the closed ash impoundments/landfills, if necessary.

Necessary permits will be evaluated based on site-specific conditions.

CHAPTER 2 – ALTERNATIVES

2.1 Summary of Alternatives

This chapter provides a description of the alternatives considered by TVA for ash impoundment closure at its coal-fired power plants. TVA's range of alternatives follows both the scope and content of alternatives considered by EPA in the CCR Rule (EPA 2015) and the recently completed framework for evaluating CCR impoundment closure options prepared by the Electric Power Research Institute (EPRI 2015b). It is recognized that there are key features of each closure scenario that are consistent across all facilities, but that specific work elements and their relative impacts are expected to vary on a plant-specific basis.

TVA developed three alternatives to the proposed action:

- Alternative A – No Action
- Alternative B – Closure-in-Place
- Alternative C – Closure-by-Removal

Each of these alternatives are described below.

EPA's View of Alternatives:

EPA asserted that either Closure-in-Place or Closure-by-Removal can be equally protective of human health and the environment if done properly

~CCR Rule Preamble

(80 Federal Register 2103, p. 21412)

2.2 Project Alternatives

2.2.1 Alternative A – No Action

Under the No Action Alternative, TVA will not close any of the ash impoundments at its coal-fired power plants. This is included because applicable regulations require consideration of a No-Action Alternative in order to provide a baseline for potential changes to environmental resources. However, the No Action Alternative is inconsistent with TVA's plans to convert all of its wet CCR systems to dry systems. It also will be inconsistent with the general direction of EPA's CCR Rule. No closure activities (i.e., no decanting of surface water or cover system construction) will occur under the No Action Alternative (Figure 2-1). The impoundments would continue to receive storm water and other process wastewaters. TVA will continue safety inspections of structural elements to maintain stability, and all impoundments will be subject to continued care and maintenance activities.

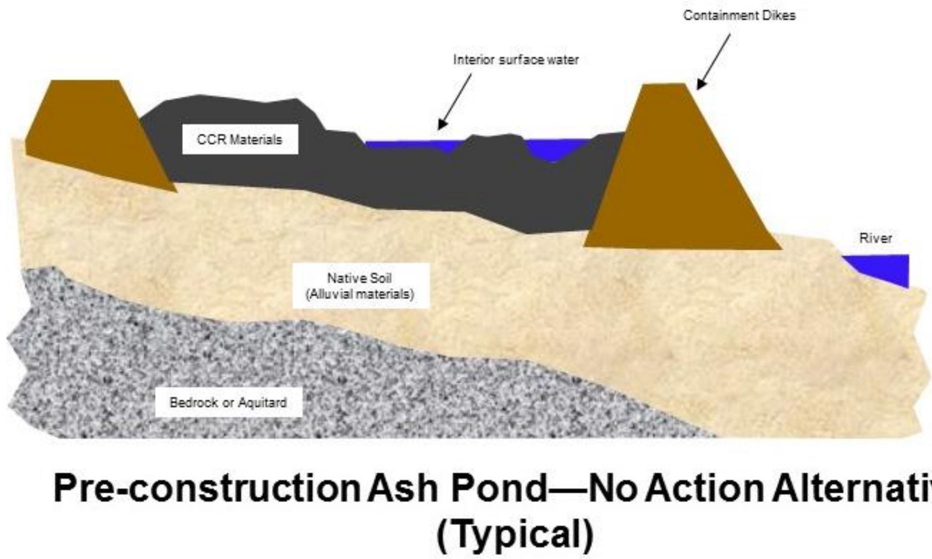

Figure 2-1. Illustration of No Action Alternative

2.2.2 Alternative B – Closure-in-Place

Closure-in-Place (Figure 2-2) involves stabilizing the CCR in place and installing a cover system. It would take 10 to 95 months to close an impoundment in place, depending on its size, the distance to the cover system borrow area location, and the condition of the road network between the borrow location and impoundment being closed. Relevant construction related information regarding Alternative B is summarized in Table 2-1 for the range of CCR impoundments managed by TVA.

Table 2-1. Summary of Relevant Fleet-wide Construction Data for Alternative B

Parameter	Estimated Quantities (per impoundment)
Size of Impoundment	<10 to 370 ac
Borrow Material Requirements	<15,000 to 4,300,000 yds^3
Closure Costs[1]	<$3,500,000 to $200,000,000
Average Truckloads of Borrow/Day[2]	Up to 175 (i.e., traffic count of 350 trips per day)
Construction Workforce	Up to 100

[1] Cost estimates are preliminary and subject to refinement based on design and construction bidding process
[2] Assumes 15 yds^3 per load.

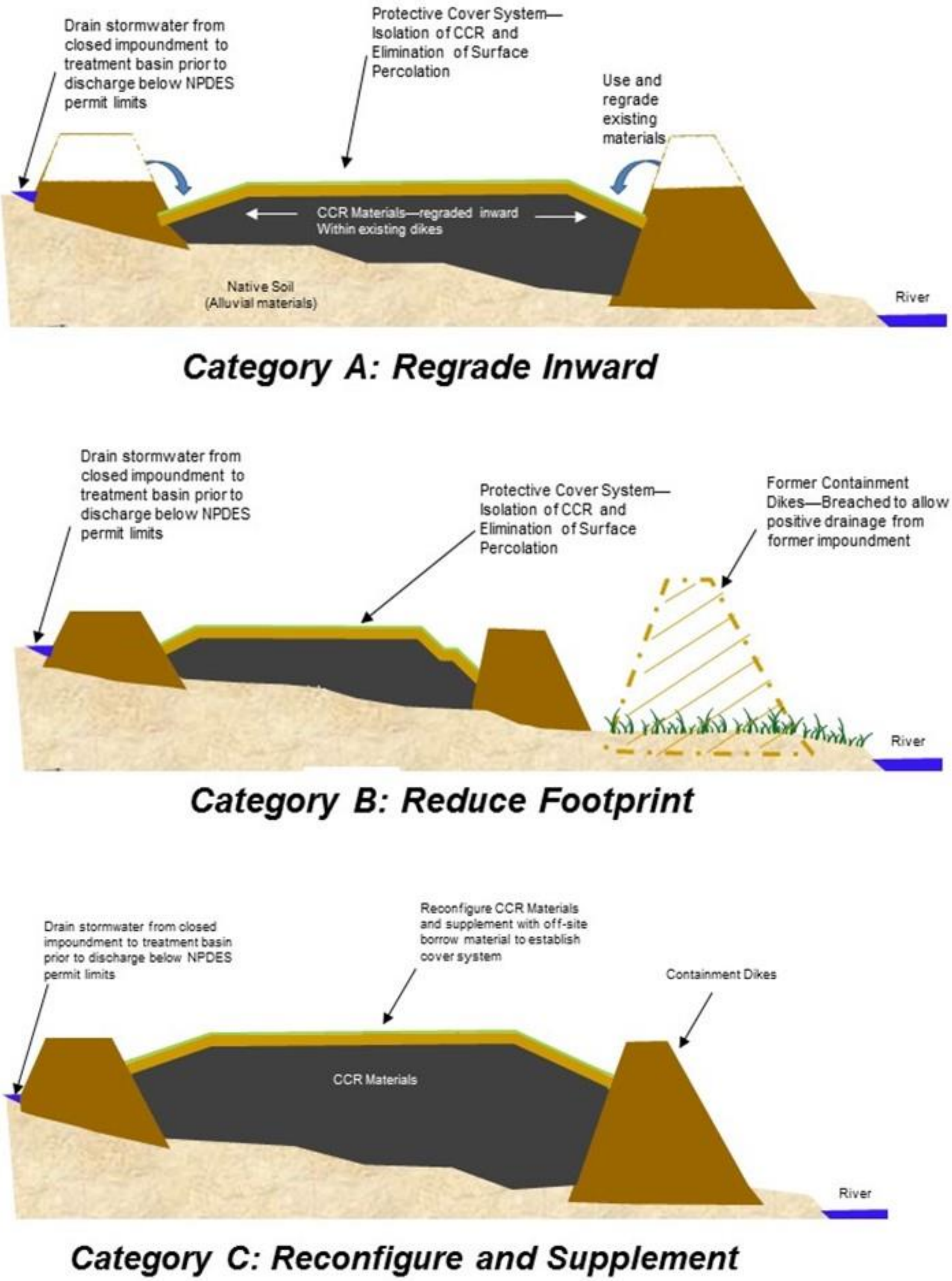

Figure 2-2. Illustration of Post-construction Condition for Closure-in-Place Options

As described by EPRI in their framework analysis (EPRI 2015b) the Closure-in-Place alternative involves a range of individual component actions that must be considered as part of the impact assessment process (Table 2-2).

Table 2-2. Summary of Proposed Activities for Closure-in-Place Alternative

Process water flow rerouting - piping modifications and/or diversion channel	✓
Closure contouring	✓
Decanting of free water within impoundment	✓
Clearing/grubbing	✓
Temporary subsurface drainage installation (where required)	✓
Drainage improvements/interim grading	✓
Material drying	✓
Utility reroutes	✓
Demolition/abandonment of site features	✓
Haul road improvements/construction	✓
Load and transport borrow material for filling and grading	✓
Installation of temporary storm water structures	✓
Installation of temporary cover soil	✓
Construction of stability improvement features	✓
Modifications to stilling impoundment (if required)	✓
Installation of temporary vegetative cover	✓
Installation of temporary erosion control measures	✓
Placement of bridging material such as rock or geogrid and installing a sump or drainage system to help dewater the material	✓
Final closure grading	✓
Geomembrane installation	✓
Installation of closure cover system drainage layer	✓
Installation of cover soil	✓
Installation of vegetation layer	✓
Installation of permanent subsurface drainage structures (where required)	✓
Installation of permanent surface water structures	✓
Installation of permanent erosion control features	✓

Note: NPDES limits will be maintained at all times; discharges will be routed through and sampled at permitted NPDES outfalls as required.

Primary actions common to all impoundment closures under Alternative B – Closure-in-Place include:

- Ensure berm stability – Previous TVA and EPA studies have determined berm safety ratings under static conditions and recommended improvements, as appropriate. TVA implemented these recommendations on a site-specific basis. As part of CCR Rule compliance, TVA is currently evaluating the seismic stability of all CCR impoundments and will make appropriate modifications to ensure that the berm stability is at a level that meets or exceeds industry acceptable factors of safety using conservative assumptions. The proposed closure grades of the impoundments will be evaluated prior to construction and any needed improvements to the berms will be made as part of the closure system construction.

- Consider opportunities for beneficial use of ash – TVA continuously evaluates opportunities to beneficially reuse ash. Such reuse may include incorporation of bottom ash from CCR impoundments as part of the impermeable cover system.
- Lower ash impoundment water level – Free standing liquid is decanted from the impoundment either actively (e.g., extraction wells, pumps, and/or trenches) or passively (e.g., gravity drainage). Decanting will be undertaken in a manner to comply with conditions of existing NPDES permits or TVA will work with appropriate federal/state agency to obtain necessary approvals.
- Identify temporary laydown areas and borrow areas – TVA anticipates temporarily using approximately 5 to 10 ac per site for vehicle and equipment parking, materials storage, and construction administration. TVA will identify on-site or off-site borrow areas.
- Grade to consolidate CCR, reduce footprint and promote site drainage – CCR layer is stabilized such that it is structurally suitable as a base layer. This stabilization could include pore dewatering, addition of amendments (e.g., Portland cement), and/or compaction. TVA will try to optimize the use of existing CCR material to achieve final grade (see options below). Fill/borrow material will be used to supplement CCR material and contoured to provide adequate storm water management.
- Install cover system (see Cover System Sub-alternatives) – TVA will install a cover system which either meets or exceeds CCR Rule cover system performance standards (1×10^{-5} permeability) or state cover system requirements. Storm water management infrastructure will maintain positive drainage. The cover system must control, minimize, or eliminate to the maximum extent practicable, post-closure infiltration of liquids into the CCR and releases of CCR, leachate, or contaminated run-off to groundwater or surface waters.

- Install or expand groundwater monitoring system, if appropriate, under federal or state requirements. If an inactive impoundment is closed prior to April 17, 2018, no federal requirements mandate installing a groundwater monitoring system. However, states may require groundwater monitoring, assessment, and if appropriate, corrective action.
- Closure documentation – Prepare documentation to demonstrate that appropriate closure activities were successfully implemented.
- Post-closure care - Long-term operations and maintenance activities (e.g., maintaining the cover system, monitoring, and reporting) are implemented, as necessary.

EPA-Required Design and Performance Standards for Cover Systems:

- Permeability less than 1x10^{-5} cm/sec
- Infiltration layer that contains a minimum of 18 inches of earthen material or other materials that achieve equivalent reduction in infiltration
- Erosion layer that contains a minimum of 6 inches of earthen material that is capable of sustaining native plant growth or other materials that provide equivalent protection from wind and water erosion
- Design minimizes disruption of cover integrity by accommodating settling and subsidence
- Control infiltration of liquids into the CCR and releases of leachate to the ground or surface waters.

★The final cover permeability must be less than or equal to the permeability of the bottom liner system or natural subsoil present and TVA will meet or exceed federal and state requirements.

Related and support activities may also be required for each closure activity. Such activities may include the following:

- Rerouting of water systems and piping to prevent future release of plant service water systems or other drainage to the closed ash impoundment. Alternative wastewater treatment may be required.
- Development of interior or exterior access roads to facilitate movement of equipment and/or transport of borrow/fill material.
- Site preparation and development of temporary laydown areas to support construction activities.
- Transportation of suitable borrow material from either on-site or off-site locations (Note: all borrow material from off-site locations are expected to be from previously permitted borrow sites for the ten ash impoundment closures discussed Part II).

Several alternate technologies are available for use in developing a cover system for each subject impoundment (Figure 2-3). EPA has identified both design and performance standards for a cover system that are sufficient to provide for environmental protection (see inset).

The technologies considered by TVA for closure-in-place provide a range of acceptable approaches that integrate various components including vegetative cover soils, low permeability zones consisting of compacted clays or geomembranes, geocomposite grids to promote interior drainage and either natural or synthetic turf. Each of these technologies prevent contact of CCR materials with percolating rainwater, promote controlled runoff to appropriate storm water discharge or detention systems and provide for aesthetic condition of the closed ash impoundment. Borrow volume requirements, construction cost, and maintenance requirements are key considerations in the selection of each technology.

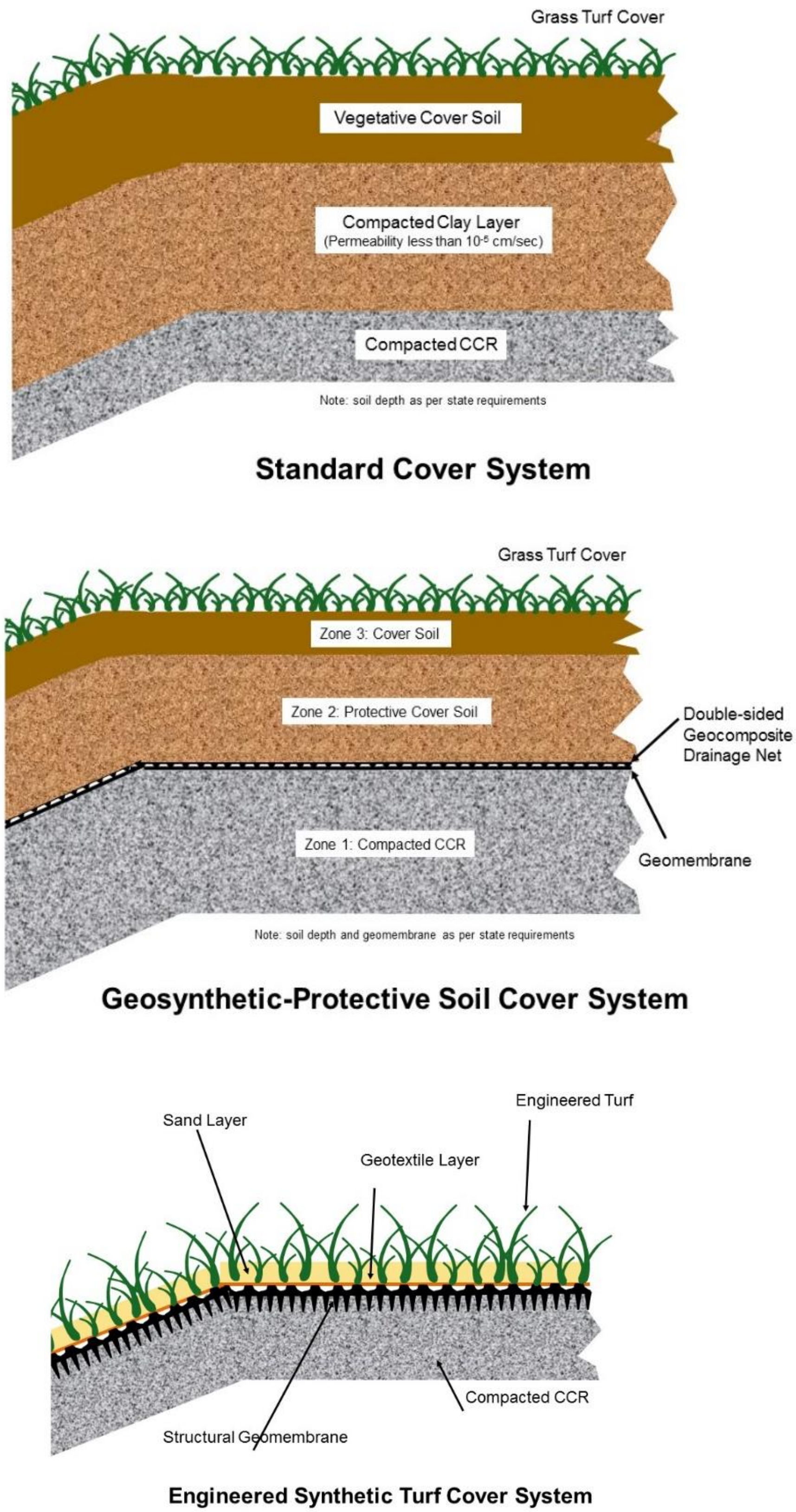

Figure 2-3. Examples of Cover System Sub-alternatives

General sub-alternatives that incorporate the above technologies that are available for consideration on a site-specific basis include the following.

Alternative B-1 – Standard Cover System

A standard soil cover system will have permeability less than or equal to the permeability of any bottom liner system or natural subsoils present or a permeability no greater than $1x10^{-5}$ centimeters per second (cm/sec). The infiltration layer must contain a minimum of 18 inches of earthen material (e.g., compacted clay layer). The erosion layer must contain a minimum of 6 inches of earthen material that is capable of sustaining native plant growth. The design must accommodate settling and subsidence to protect the cover system integrity. Individual states may require greater thickness of the infiltration and erosion layers, such as Tennessee which requires permeability no greater than $1x10^{-7}$ cm/sec, a 24-inch infiltration layer, and a 12-inch erosion layer (see Figure 2-3).

Alternative B-2 – Geosynthetic-Protective Soil Cover System

A combination of a geosynthetic liner and protective cover soils excludes the need for the compacted clay layer. This cover system will achieve a permeability performance less than or equal to the standard cover system (better). An example geosynthetic-protective soil cover system from bottom to top includes a geomembrane liner barrier layer (infiltration layer)(e.g., high density polyethylene (HDPE)), geocomposite drainage layer, and a minimum of 18 to 24 inches of a protective soil cover (the top 6 to 12 inches of earthen material being capable of sustaining native plant growth -erosion layer) (see Figure 2-3).

Alternative B-3 – Engineered Synthetic Turf Cover System

An engineered synthetic turf cover system from top to bottom will include synthetic turf on top to provide protection from ultraviolet degradation and erosion (erosion layer). It will have sand infill to act as ballast against wind uplift on the synthetic turf layer. Below that will be a drainage system and then the geomembrane liner barrier layer (infiltration layer) (see Figure 2-3).

TVA has also been studying the potential use of flowable fill as a means of closing impoundments that will beneficially re-use CCRs in lieu of soil and other natural materials. A pilot study has been initiated at the Gallatin Fossil Plant (GAF) in consultation with the Tennessee Department of Environment and Conservation (TDEC) to use the Flue Gas Desulfurization (FGD) scrubber material as a feedstock for the production of an Engineered Fill (EF) product that can be generated on-site and beneficially used in the closure of the ash impoundments. The purpose of the EF pilot study is to evaluate the performance of various mixes of EF, select a preferred mix design for the full-scale implementation of the project and determine whether the EF material is suitable for beneficial reuse based on EPA requirements provided in the CCR Rule. Among its qualities are uniformity, known strength in place, higher bearing capacity, lower permeability, increased stability and its capacity to set under water. Expected benefits of the EF application are to improve the cementitious properties of the CCRs to generate a fill material that self-compacts and solidifies, providing a fill material that can be pumped to an area of the ash ponds in order to improve soft subgrade conditions and provide enough strength to allow for construction equipment to grade the ash ponds to drain and construct a closure cover system. Depending on the outcome of the pilot study, TVA may expand the application of this technology as a viable component of closure design at other facilities.

No federal post-closure care measures are required if an inactive ash impoundment is closed by April 17, 2018 (or if CCR is removed [Alternative C, below]). Based on the EPA rule, it is anticipated that the states will further define monitoring and corrective action requirements. TDEC is assessing all ash storage in the state and may require monitoring, assessment activities, corrective action, and post-closure recordkeeping requirements for closed inactive ash impoundments similar to the CCR Rule requirements for active ash impoundments. Alabama and Kentucky are defining their monitoring and corrective action requirements for CCR impoundments. In anticipation of this, TVA has outlined the following process as a built-in mitigation measure that will be implemented as appropriate, in coordination with state regulatory agencies to help ensure environmental protection for closure of inactive impoundments:

1. Design and implement groundwater monitoring system.
2. Identify statistical procedures for evaluation of groundwater monitoring data.
3. Assess groundwater conditions in proximity to closed ash impoundment.
4. If needed, identify corrective measures to prevent further releases or remediate identified releases.

For active ash impoundments, a similar process for groundwater assessment and protection will be implemented to ensure compliance with CCR Rule requirements and minimize environmental impacts.

2.2.3 Alternative C – Closure-by-Removal

Closure-by-Removal (Figure 2-4) involves excavating and relocating the CCRs from the ash impoundment in accordance with federal and state requirements to an approved on-site or off-site disposal facility. Relevant construction related information regarding Alternative C is summarized in Table 2-3.

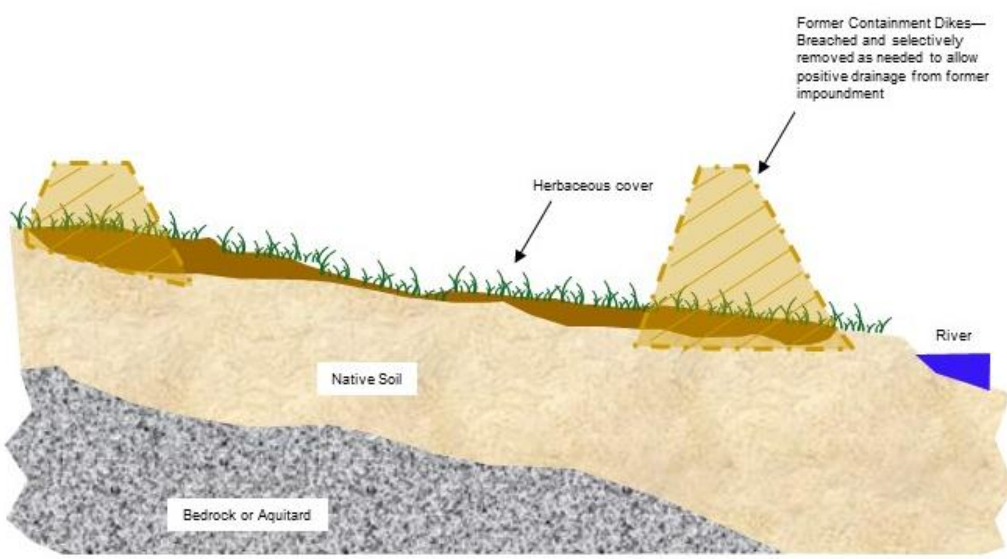

Figure 2-4. Illustration of Post-Construction Condition for Closure-by-Removal Alternative

Table 2-3. Summary of Relevant Fleet-wide Construction Data for Alternative C

Parameter	Quantities (per impoundment)
Plant Ash Impoundment Area	<10 to 370 ac
Borrow Material Requirements	<15,000 to 4,300,000 yds^3
CCR Removal	<145,500- 25,000,000 yds^3
Closure Costs[1]	<$15,000,000 to $2,700,000,000
Average Truckloads CCR/Day[2]	Up to 100 (i.e., traffic count of 200 trips per day)
Average Truckloads Borrow/Day[3]	Up to 175 (i.e., traffic count of 350 trips per day)
Construction Workforce	Up to 100

[1]Cost estimates are preliminary and subject to refinement based on design and construction bidding process
[2]Material will be dried to a reasonable degree to support transport. Assumes 10 yds^3 per load. Constraints due to increased distance to landfill and landfill operational hours limit truck transport rate.
[3] Construction operations would be sequenced, therefore transportation of borrow material would occur after all CCR is removed.

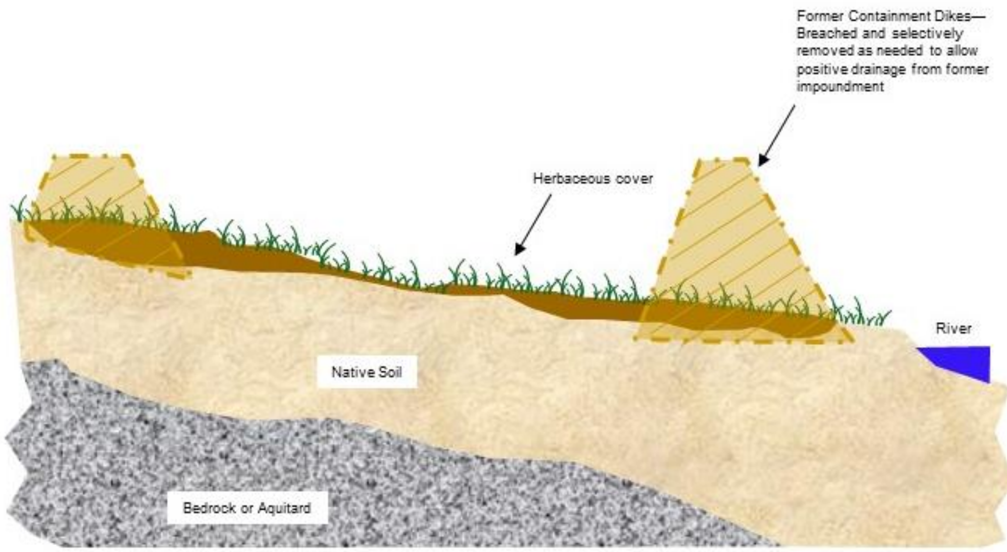

Figure 2-5. Illustration of Post-Construction Condition for Closure-by-Removal Alternative

The CCR may also be beneficially used in products or structural fills. Closure-by-Removal involves a range of individual component actions that must be considered as part of the impact assessment process (Table 2-4).

Table 2-4. Summary of Proposed Activities for Closure-by-Removal Alternative

Process water flow rerouting - piping modifications and/or diversion channel	✓
Closure contouring	✓
Decanting of free water within impoundment	✓
Clearing/grubbing	✓
Temporary subsurface drainage installation (where required)	✓
Drainage improvements/interim grading	✓
Material drying	✓
Utility reroutes	✓
Demolition/abandonment of site features	✓
Haul road improvements	✓
Installation of temporary storm water structures	✓
Modifications to stilling impoundment (if required)	✓
Excavate dried/stabilized CCR	✓
Load and transport CCR to off-site landfill	✓
Load and transport borrow material for filling and grading	✓
Final site preparation of abandoned impoundment	✓
Installation of cover vegetation	✓
Installation of permanent erosion control features	✓

The duration of Closure-by-Removal projects will depend on a number of factors including, primarily, the amount of CCR material that will have to be removed from the impoundment and the amount of borrow material that will have to be moved to the site to fill in the excavated hole. TVA estimates that these projects would take 12 months to approximately 70 years to complete. Key actions associated with this alternative may include:

- Lower the ash impoundment water level – As with Alternative B, free standing liquid is decanted from the impoundment either actively or passively. Decanting is undertaken in a manner that complies with existing NPDES permits or TVA will work with appropriate federal/state agency to obtain necessary approvals.
- Consider opportunities for beneficial use of ash.
- Identify on-site or off-site permitted management facilities for CCR disposal (including lining the bottom of an ash impoundment and then replacing CCR).
- Determine borrow material options (e.g., on-site or off-site).
- Excavate CCR and liner (if any) and transport to a Subtitle D permitted landfill.
- Fill and grade ash impoundment, preventing future impoundment of water.
- Revegetate with native plants.
- Closure documentation – Determine that CCR materials in the impoundment and any areas affected by releases from the CCR impoundment have been removed to the accepted level and groundwater monitoring demonstrates that all concentrations of the assessment monitoring constituents do not exceed background levels or maximum contaminant levels.

2.2.4 Modes of Material Transport

TVA considered several modes of transport of bulk materials that may be required for impoundment closure alternatives. Potential modes of transport include trucking, rail and barge. Advantages and disadvantages of each mode are summarized in Table 2-5 and factor into the applicability and appropriateness of the hauling method. Primary factors considered include:

- volume of material;
- distance of the haul route to a permitted landfill or borrow area;
- availability of the infrastructure to manage the transfer of material;
- cost effectiveness; and
- schedule allowed for the hauling.

Table 2-5. Advantages and Disadvantages of Hauling Methods

Haul Method	Advantages	Disadvantages
Truck	• Sites (borrow sites, ash impoundments and landfills) are readily served by roads • Does not require special loading/unloading infrastructure • Can accommodate short schedules for lower volume materials	• Lower volume per load • Requires more vehicles due to smaller vehicle capacities • Potential for increased impacts (air quality, noise, vibration, road deterioration) to road system and to adjacent land uses • Increased risk of crashes on roadways • Extended schedule for high volume materials
Barge	• Good for shipments of large quantities • Good for shipments over longer distances • Relatively less impact to roadside land uses • Relatively safer than shipping by truck or rail	• Borrow sites not typically served by barge • Requires loading/unloading infrastructure (chutes, conveyors, etc.) • Landfills not typically served by barge (may require some trucking) • Potential for increased impacts (spills) • Transport prevented if water levels are low
Rail	• Good for shipments of large quantities • Good for shipments over longer distances • Relatively less impact to roadside land uses	• Borrow sites not typically served by rail • Requires loading/unloading infrastructure (chutes, conveyors, etc.) • Landfills not typically served by rail (may require some trucking) • Potential for increased impacts

2.2.4.1 Transport of Borrow Material

TVA considered the potential use of trucking, barge and rail as modes to transport borrow material under Alternatives B and C. Use of rail and barge to transport borrow material were eliminated from detailed consideration as these modes are not suitable for short-duration, local movement of borrow materials. The volume of borrow material required is generally considered to be small (relative to CCR volumes) and borrow material is likely to come either from on-site or from previously developed off-site borrow sites. Furthermore, use of trucking does not require the development of secondary facilities (rail spur, loading/

unloading systems, stockpile areas, etc.) that may be required to load and unload materials to/from rail and barge facilities. Such facilities are generally lacking at borrow sites and if developed, would still require truck use to haul materials to the loading facilities. Development of such facilities would also result in additional environmental impacts (land use, wetlands, water resources, etc.) and would require additional environmental permitting. For Alternatives B and C, therefore, trucking is considered to be the only feasible mode of transportation that may be considered for the movement of borrow.

2.2.4.2 Transport of CCR Material

TVA considered three methods of transportation of CCR under Alternative C: truck, barge and rail. To haul CCR using each of these methods would require the receiving shipping container to be lined to prevent spills and leaks.

Transport of CCR by trucking under Alternative C would require the use of large numbers of vehicles and operators. Trucking is an effective mode of transport as it uses the existing roadway infrastructure to readily serve the plant site subject to impoundment closure and the receiving landfill. Additionally, trucks do not require special loading/unloading infrastructure and can be effective in meeting short schedules for impoundment closures where CCR volumes are relatively small (e.g., 500,000 yd^3 or less). In contrast, because the volume per truck is comparatively much smaller than that of either rail or barge, the use of trucks could result in prolonged removal durations and higher truck volumes where CCR volumes are large. Such long removal durations and greater truck volumes have the potential to result in notable impacts (air quality, noise, vibration, road deterioration) to the road system and to adjacent land uses. Because of it positive factors, this mode of transportation was retained for consideration as potentially viable for the Closure-by-Removal alternative.

Transport by barge would require equipment, loading and unloading infrastructure and a barge transportation service at both TVA's coal-fired plant and at a location near the receiving landfill. While many of TVA’s coal-fired plants have barge facilities, these facilities are configured and designed to off-load coal from barges. They are not configured with supporting loading systems (stockpile areas, loading infrastructure such as conveyors and clamshell dredges, etc.). Development of such supporting loading systems at each plant would be costly, require permits, cause schedule delays, and would result in additional environmental impacts. Similarly, substantial environmental impacts, permitting requirements, and cost would also be required to develop barge unloading facilities to serve receiving landfills under this alternative. Barge unloading facilities are not typical near permitted landfills. Therefore, CCR hauled by barge would still need to be unloaded and shipped via truck to a receiving Subtitle D landfill. Even if a barge transfer facility is near a permitted landfill, there exists the risk of CCR spills in the water during loading, shipping, and unloading at the transfer facility. There is also the likelihood that an existing barge transfer facility would need to be modified to handle the off-loading of CCR from a barge. For inactive impoundments, the lack of existing barge facilities that could handle CCR and the limited time for closure (approximately 18 to 24 months) are additional concerns. Because of these factors, and uncertainty related to environmental permitting of these facilities, this mode of transportation was eliminated from consideration as unfeasible

Like barge transport, rail transport would require the installation of loading and unloading infrastructure, and a rail transportation service in the form of a rail carrier. Rail cars dedicated for use as CCR transport would also have to be acquired and provided to support CCR removal operations. Rail facilities would have to be expanded and improved at most facilities to support CCR loading and unloading operations. An assessment of permitted Subtitle D landfills in Tennessee, Kentucky and northern Alabama shows that there is a very low percentage of landfills that can accept waste directly by rail. Even if a landfill is near a rail line, additional infrastructure would likely need to be developed to support the unloading operations in the vicinity of the receiving landfill. Because the CCR is not likely to be off-loaded directly from rail to a permitted landfill (unless a rail spur is designed, permitted and constructed), some amount of over-the-road trucking will still be needed in most cases to haul the CCR to a landfill. Supporting infrastructure would also be required to provide for offloading of CCR from rail to trucks. Substantial environmental impacts including potential disproportionate social impacts, permitting requirements and additional expense would also result from the development of such facilities under this alternative.

The cost effectiveness of shipping by rail is also a factor. Shipments of larger CCR volumes over longer distances can help offset the costs of loading and unloading the material. However, shipping by rail becomes less feasible for shorter distances and smaller CCR volumes. Unless haul distances are relatively long and the volume of CCR is relatively large, rail is not considered economically feasible. Additionally, there is substantial time and uncertainty related to environmental permitting of rail loading and unloading facilities. Because of these factors, this mode of transportation may not be feasible for short-term closure activities associated with inactive impoundments and for low volume ash impoundments, but may be viable for the Closure-by-Removal alternative for impoundments having large volumes CCR and longer term closure schedules.

2.2.5 Screening Factors to Evaluate Alternatives

Recognizing the potential pathways for exposure and risk related to existing ash impoundments (Figure 2-6), TVA developed a series of factors important in the screening and evaluation of project alternatives. In determining whether an alternative is a reasonable action, TVA conducted a screening analysis to determine the reasonability of the “action” alternatives by evaluating a range of key issues and factors and the feasibility of undertaking closure activities. Key factors that TVA considered included the following:

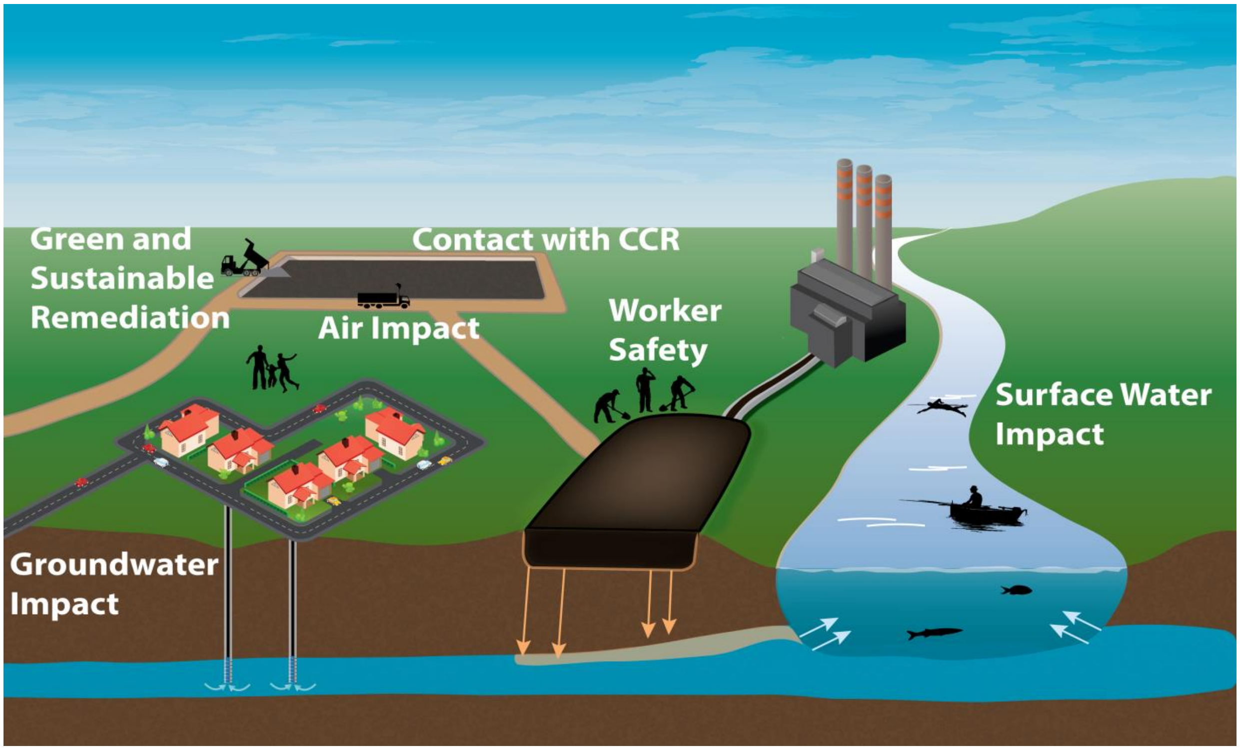

Figure 2-6. Framework Pathways for CCR-Related Risk (Source: EPRI 2015a)

- Volume of CCR materials. The size of an ash impoundment and volume of CCR may affect closure activities and appropriateness of an alternative.
- Schedule. Time necessary to complete closure activities at an ash impoundment may affect the reasonability of closure alternatives. EPA included timeframes for the closure of both inactive impoundments and active impoundments (a limited number of extensions may be granted for active impoundments). The CCR Rule is structured to encourage regulated entities to accelerate the closure of CCR impoundments because of the decrease in groundwater risk that results from eliminating the hydraulic head of ponded water. The CCR Rule is structured to encourage utilities to cease disposing of CCRs in impoundments by October 19, 2015, and complete closure activities by April 17, 2018.
- Stability. Stability of the CCR facilities was evaluated by TVA (Dewberry Consultants, 2010 through 2013). Safety ratings under static conditions were determined to be adequate at ash impoundments in previous studies submitted to EPA. TVA is currently evaluating the seismic stability of all CCR facilities and will make appropriate modifications to ensure that the berm stability is at a level that meets or exceeds industry acceptable factors of safety using conservative assumptions. The proposed closure grades of the facilities will be evaluated prior to construction and any needed improvements to the berms will be made as part of the closure system construction.
- *Risk to Human Health and Safety.* Closure activities entail a range of construction activities that represent a potential risk to the health and safety of the workforce and the public. Worker safety is a particular concern as heavy equipment and difficult working conditions would occur for any closure activities. However, excavations into

the ash impoundment under the Closure-by-Removal alternative are particularly dangerous as noted by reports of accidents leading to injury or death in the industry (Mitchell 2006). Additionally, as discussed in Section 3.16, sites having large volumes of CCR that are considered for Closure-by-Removal may also result in extensive trucking operations that would increase worker safety concerns as well as potential safety to other motorists along haul routes.

- Potential human health risk was also considered by reviewing the results of groundwater monitoring and the incidence of surface water releases to receiving waterbodies. Records of releases or issues of concern that represent a risk to human health from CCR constituents associated with the existing impoundments will be evaluated on a per site basis. Closure-by-Removal also would require a substantially greater number of truck movements into and out of the site which would potentially increase the risk of injuries and fatalities associated with truck crashes.
- *Potential Effects to Wetlands.* Under the CWA, wetlands are considered special aquatic sites deserving of special protection because of their ecologic significance. Wetlands are important, fragile ecosystems that must be protected, and EPA has long identified wetlands protection as a high priority.
- *Risk to Adjacent Environmental Resources.* Risk of potential release and degradation of sensitive environmental resources (air, groundwater, surface water, ecological receptors, and factors related to the human environment) with a potential nexus to the CCR impoundment is an important consideration for alternative development. TVA is currently conducting studies to identify the uppermost aquifer and this depth is not yet known for existing impoundments.
- *Mode and Duration of Transport Activities.* The activities related to transport of borrow (Alternative B and Alternative C) and CCR removal and transport (Alternative C) require the use of large numbers of vehicles and operators. Additionally, closure of both inactive and active impoundments must meet the schedule limitations established by the CCR Rule. For those sites with CCR volumes exceeding 500,000 yd^3, TVA determined that for inactive impoundments insufficient time is available within the construction schedule to effectively remove the CCR materials and achieve closure by April 17, 2018 (Figure 2-7). For those impoundments containing greater volumes of CCR the duration of removal activities by trucking would extend for prolonged periods and would likely result in greater environmental impacts associated with noise and emissions, degradation of roadway infrastructure, increased risk of injuries and death, and increased potential for accidental release.

  Transport of borrow or CCR by truck poses some risk of increased traffic crashes. As the number of truck movement miles increase, both for Alternatives B and C, the risk of traffic crashes, including personal injuries and fatalities, increases. A Kentucky Transportation Center September 2013 investigation of heavy truck accidents in Kentucky analyzed accident data for 2008-2012 (UK 2013). The number of annual crashes involving trucks ranged from 7,442 to 9,092 while the number of fatal crashes involving trucks ranged from 70 to 105. For the five-year period studied, truck accidents represented 6.4 percent of all crashes, 5.5 percent of injury crashes, and 12.2 percent of fatal crashes. The statewide crash rate per 100 million vehicle miles (MVM) ranged from 163 to 226. On rural roadways, statewide crash rates ranged from 183 to 217 per 100 MVM on two-lane roadways. Therefore, there is the potential for increased crash rates on roadways being used by heavy trucks to haul either borrow or CCR.

Transport of CCR materials by barge or rail operations must consider both the volume of CCR materials to be removed (cost-effectiveness and duration of removal operations), logistics related to supporting infrastructure (loading and unloading facilities), the availability of off-loading terminals at receiving landfills, increased risk of injuries and death, and increased potential for accidental release.

- *Excessive Cost.* Excessive closure costs may affect the reasonableness of an alternative.

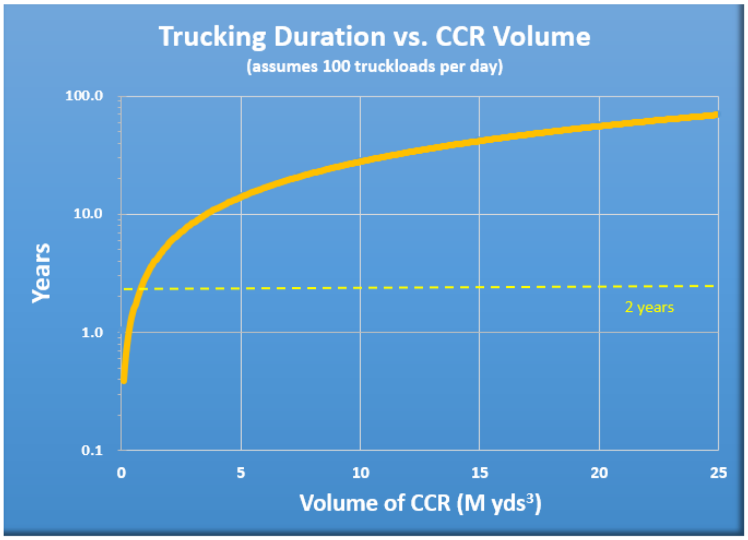

Figure 2-7. Number of Trucks vs. CCR Removal Volume

2.3 EPRI Model

Working with a contractor, EPRI has developed a comprehensive model (a framework) to assess and compare the potential health and environmental impacts of the two CCR closure alternatives, Closure-in-Place and Closure-by-Removal. EPRI is refining the model and TVA is still evaluating it. This could provide TVA, other utilities, regulatory agencies, and other interested entities a standard technical foundation for making decisions about impoundment closure approaches. Results from the EPRI's analyses of impoundment closure at a hypothetical coal-fired power plant located on a large river in Tennessee have been incorporated in several key resource analyses in Chapter 3 to provide additional support to the understanding of potential environmental impacts from alternatives under consideration (EPRI 2015c). This section provides more information about this model and its potential usefulness.

EPRI researches, develops, and demonstrates solutions to technical issues affecting the generation, delivery, and use of electricity. It is a nonprofit organization. EPRI was created by the electric utility industry in response to Congressional concerns following the 1965 blackout of parts of the Northeast, including New York City. Although funded by the utility industry, it is an independent entity, and its advisory council consists of individuals with diverse backgrounds including members from public utility commissions, environmental and consumer advocacy groups, academia, and financial institutions.

EPRI's consultant explains that the CCR impoundment closure model quantifies potential relative impacts to environmental media associated with each closure scenario, including groundwater, surface water, and ambient air. In addition to environmental media, the model also quantifies potential relative impacts to safety of workers and nearby residents from construction activities, including the transportation of materials to and from the site and the use of natural resources (e.g., energy, water and materials) associated with each closure scenario. The Closure-in-Place scenario analyses include both CCR impoundments located above and in aquifers.

Consistent with EPA's technical determinations underlying its CCR Rule, EPRI's model results show that either closure method would have positive effects on groundwater and surface water. The model concludes that the Closure-by-Removal would improve surface water and groundwater quality more than Closure-in-Place, especially if the bottom of a CCR impoundment is in an aquifer. In contrast, the Closure-by-Removal alternative has significantly greater risks than does the Closure-in-Place alternative to public and worker safety (more injuries and fatalities), greater air quality impacts and greater emissions of greenhouse gases. The overall conclusion that TVA draws from these model results is that in most situations, Closure-in-Place likely will be more environmentally beneficial than Closure-by-Removal, especially when the amount of borrow and CCR material that must be moved to and from a site is substantial. This does not mean that Closure-by-Removal would necessarily be environmentally unacceptable on a site-specific basis.

The conclusions from EPRI's model helps to confirm EPA's assertion that either Closure-in-Place or Closure-by-Removal can be equally protective if conducted properly, but EPA predicted that most CCR impoundments would be closed in place because of the expense and difficulty of closing by removal.

2.4 Summary of Public and Agency Scoping Process

TVA received 48 responses regarding the NOI. These responses included 18 individual responses, one form letter (submitted by 26 individuals), and two sets of comments from groups of interested parties. TVA also received comments from the Alabama Department of Environmental Management (ADEM), Kentucky Department of Environmental Protection (KDEP), TDEC and the U.S. Fish and Wildlife Service (USFWS).

Participants submitted a variety of comments and opinions ranging from requesting TVA to keep ash impoundments open to protect wildlife habitat; to close all ash impoundments; to support for Closure-by-Removal or Closure-in-Place. Several commenters also requested that TVA consider beneficial reuse of coal ash and consider alternative closure options. Concerns relating to groundwater quality, impacts of off-site disposal on low-income and minority populations, compliance with the CCR Rule and TDEC Order, the need for public involvement, and the applicability of a programmatic review were also expressed.

TVA also received agency letters from the USFWS Kentucky, Tennessee, and Alabama field offices. In its letter, the USFWS noted that TVA should work with the local field office to ensure the most recent information regarding federally listed species and designated critical habitat is assessed. The USFWS also requested that TVA continue to consult with state and federal resources throughout the planning process. A TDEC letter requested that TVA consider impacts to air quality, groundwater and surface water impacts, beneficial use of ash, and identify all actions required to obtain the proper permits from TDEC.

The following is a brief summary of the most prevalent issues and comments expressed during the scoping period:

- TVA should consider keeping the ash impoundments open for future wildlife use, especially for bird habitat at the ALF East Impoundment.
- TVA should consider beneficial use of CCR.
- TVA should consider impacts of off-site disposal of CCR on low-income and minority populations.
- Groundwater impacts should be considered.
- Surface water impacts should be considered.
- TVA must demonstrate compliance with the EPA CCR Rule and the TDEC Order.

2.5 Comparison of Alternatives

The environmental impacts of Alternative B and Alternative C are analyzed programmatically in detail in this section and are summarized in Table 2-6. These summaries are derived from the information and analyses provided in the Affected Environment and Environmental Consequences sections of each resource in Chapter 3.

Table 2-6. Summary and Comparison of Alternatives by Resource Area

Issue Area	Alternative A – No Action	Alternative B – Closure-in-Place	Alternative C – Closure-by-Removal
Closure Cost	$0	<$3.5 to 150 million	<$15 million to 2.7 billion
Air Quality	No impact	Temporary minor impacts from fugitive dust and emissions from equipment and vehicles during construction and transport of borrow material.	Notably greater emissions (relative to Alternative B) from fugitive dust and emissions from equipment and vehicles during construction and transport of borrow and CCR material. For sites with large volumes of CCR magnitude of impact would be greater due to increased operation of on-site equipment and increased duration and frequency of off-site trucking. No exceedances of NAAQS expected for sites in attainment areas. No further deterioration of air quality is anticipated in the non-attainment areas for particulates and ozone.
Climate Change and Greenhouse Gases (GHG)	No impact	Construction and trucking operations of borrow material contributes to emissions of GHG.	Construction and trucking operations of CCR removal and borrow material contributes to emissions of GHG. For sites with large volumes of CCR, magnitude of impact would be greater due to increased operation of on-site equipment and increased duration and frequency of off-site trucking.
Land Use	No impact as no change in industrial land use	No impact as no change in industrial land use. Temporary impacts associated with the	No impact as no change in industrial land use. Impacts associated with the conversion of some vacant areas to laydown areas. Minor beneficial impact

Table 2-6. Summary and Comparison of Alternatives by Resource Area

Issue Area	Alternative A – No Action	Alternative B – Closure-in-Place	Alternative C – Closure-by-Removal
		conversion of some vacant areas to laydown areas.	as land could be reused for an alternative use following closure.
Prime Farmland	No impact	No impact	No impact
Geology and Seismology	Marginal improvement to static and seismic factor of safety of the impoundment.	Stable under static conditions. Stability increased by removal of hydraulic head. Seismic stability under evaluation and mitigable.	No impacts or risks of failure.
Groundwater	Risk to groundwater is not reduced.	Reduction of hydraulic input reduces risk of migration of constituents to groundwater.	Reduces risk to groundwater by removing CCR from impoundment. Less short term benefit for sites having high volume of CCR materials.
Surface Water	Risk to surface water is not reduced.	Risk to surface water would be reduced. Construction-related impacts would be negligible.	Risks to surface water would be reduced. Construction-related impacts would be negligible.
Floodplains	Impacts to floodplains unchanged.	Reduces risk and extent of CCR migration into surface water during potential flooding event.	Removes risk of CCR migration into surface water during potential flooding event. Potential to incrementally increase floodplain storage.
Vegetation	No impact	Limited to construction-phase disturbance of largely industrialized environmental settings that lack notable plant communities. Minor and adverse in the short term, but minor and positive in the long term.	Limited to construction-phase disturbance of largely industrialized environmental settings that lack notable plant communities. Minor and adverse in the short term, but minor and positive in the long term.
Wildlife	No impact	Minor impact to predominantly previously disturbed low quality habitats during the construction phase.	Minor impact to predominantly previously disturbed low quality habitats during the construction phase.
Aquatic Ecology	No impact	No adverse impact	No adverse impact
Threatened and Endangered Species	No impact to threatened or endangered species.	No impact to threatened or endangered species. For sites that require limited tree removal potential impacts to threatened and endangered species would be minor.	No impact to threatened or endangered species. For sites that require limited tree removal potential impacts to threatened and endangered species would be minor.

Table 2-6. Summary and Comparison of Alternatives by Resource Area

Issue Area	Alternative A – No Action	Alternative B – Closure-in-Place	Alternative C – Closure-by-Removal
Wetlands	No impact	No direct impact. Potential minor indirect impact may occur during construction. These would be minimized through BMPs.	No direct impact. Potential minor indirect impact may occur during construction. These would be minimized through BMPs.
Socioeconomic Resources	No impact	Short-term beneficial increases in employment and income during construction.	Short-term beneficial increases in employment and income. The larger the CCR volume the longer the benefits would last due to increased construction periods. Potential impacts to community services due to increased demand on workforce and equipment.
Environmental Justice	No impacts to EJ communities.	Impacts associated with the transport of borrow and CCR material (construction related noise, exposure to fugitive dust and exhaust emissions) to or from identified EJ communities. These impacts would be short term and generally minor.	Impacts associated with the transport of borrow and CCR material (construction related noise, exposure to fugitive dust and exhaust emissions) to or from identified EJ communities. For sites with large volumes of CCR magnitude of impact would be greater due to increased duration and frequency of off-site trucking have greater effects to EJ communities.
Natural Areas, Parks and Recreation	No impacts	Potential long-term impact if recreational sites are closed as a result of impoundment closure activities.	Potential long-term impact if recreational sites are closed as a result of impoundment closure activities.
Transportation	No impacts	Temporary minor impacts from transport of borrow material.	Impact magnitude dependent upon CCR volume and removal duration. For sites with large volumes of CCR magnitude of impact would be greater due to increased duration and frequency of off-site trucking resulting in additional impacts to local traffic and increase need for roadway maintenance. Impacts on level of service of roadway network notably greater for sites having large CCR volumes and short removal durations, resulting in increased risk of injuries and deaths.
Visual Resources	No impacts	Minor impacts during construction. Beneficial in long term.	Minor impacts during construction. Beneficial in long term.
Cultural Resources	No impacts	No impacts due to use of previously disturbed lands.	No impacts due to use of previously disturbed lands.
Noise	No impacts	Temporary minor construction noise impacts from equipment and vehicles.	Minor construction noise impacts from equipment and vehicles. For sites with large volumes of CCR magnitude of impact would be greater due to increased duration and frequency of off-

Table 2-6. Summary and Comparison of Alternatives by Resource Area

Issue Area	Alternative A – No Action	Alternative B – Closure-in-Place	Alternative C – Closure-by-Removal
			site trucking resulting greater noise impacts.
Solid and Hazardous Waste	No impacts	Minimal amounts generated during construction activities and managed in permitted facilities.	Minimal amounts generated during construction activities and managed in permitted facilities.
Public Health and Safety	No reduction in public health and safety risks to groundwater and surface water.	Temporary potential for impacts during construction activities and transportation of borrow material.	Potential for impacts during construction activities and transportation of borrow material and CCR. Increased risk associated with deep excavation of CCR impoundments. Notably greater risk to worker safety and traffic related safety associated with sites having high CCR volumes
Cumulative Effects	No impacts	Beneficial cumulative impact to groundwater quality in the region from closure of CCR impoundments.	Beneficial cumulative impact to groundwater quality in the region from removal of CCR from impoundments. Adverse cumulative impact to traffic operations within the TVA region. Cumulative impacts to air quality, noise, land use, natural resources socioeconomics, EJ communities and public health and safety would be expected and greater than Alternative B due to greater trucking and secondary effects on regional landfill capacity.

2.6 Alternatives to be Carried Forward for Detailed Analysis

Initial screening analysis by TVA determined that Alternative A – No Action would not be a reasonable alternative. Nonetheless, Alternative A – No Action is discussed in Part I of the PEIS to provide a benchmark against which to compare the environmental effects of the proposed action alternatives, Alternatives B and C.

Alternative B – Closure-in-Place and Alternative C – Closure-by-Removal both meet the purpose and need to close ash impoundments and are reasonable alternatives for this PEIS. In the preamble to the CCR Rule, EPA asserted that either Closure-in-Place or Closure-by-Removal can be equally protective of human health and the environment if done properly (80 FR 21412). Therefore, TVA will carry forward both alternatives to be analyzed for environmental effects.

EPA observed that most impoundments would be closed using the Closure-in-Place alternative because of the difficulty of demonstrating that all CCR in the impoundment and any areas affected by CCR releases from the impoundment have been addressed appropriately and the cost of the Closure-by-Removal alternative.

Site-specific analysis for closure activities at individual ash impoundments will tier off the programmatic analysis, will re-evaluate the reasonableness of alternatives under consideration and will result in the identification of a preferred closure alternative.

2.7 Summary of Mitigation Measures

Mitigation measures identified in Chapter 3 to avoid, minimize, or reduce adverse impacts to the environment are summarized below. Any additional project-specific best management practices (BMPs) will be identified on a site-specific basis.

- Fugitive dust emissions from site preparation and construction will be controlled by wet suppression and BMPs (CAA Title V operating permit incorporates fugitive dust management conditions).
- Erosion and sedimentation control BMPs (e.g., silt fences) will ensure that surface waters are protected from construction impacts.
- Consistent with EO 13112, disturbed areas will be revegetated with native or non-native, non-invasive plant species to avoid the introduction or spread of invasive species.
- BMPs will be used during construction activities to minimize and restore areas disturbed during construction.
- TVA will implement supplemental groundwater mitigative measures that could include monitoring, assessment, or corrective action programs as mandated by state requirements. State requirements provide an additional layer of groundwater protection to minimize risk.

CHAPTER 3 – AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

3.1 Air Quality

3.1.1 Affected Environment

Air quality is a vital resource that impacts us in many ways. Poor air quality can affect our health, ecosystem health, forest and crop productivity, economic development and our enjoyment of scenic views. This section summarizes current conditions and trends over the past 35 years for key air quality issues. Air quality within the TVA region has steadily improved over the past 35 years.

The CAA is the comprehensive law that affects air quality by regulating emissions of air pollutants from stationary sources (such as power plants) and mobile sources (such as automobiles). It requires the EPA to establish National Ambient Air Quality Standards (NAAQS) and directs the states to develop State Implementation Plans to achieve these standards. This is primarily accomplished through permitting programs that establish limits for emissions of air pollutants.

For the purpose of this PEIS, the affected environment is the TVA Power Service Area (PSA) shown in Figure 3-1. This service area includes the 178 counties in a seven state region and has an estimated population of about 10 million people. Additional focus is on the 11 counties where TVA's coal-fired power plants are located. The primary air quality parameters of concern for this PEIS are five criteria air pollutants (carbon monoxide [CO], nitrogen dioxide [NO_2], ozone, particulate matter [PM], sulfur dioxide [SO_2), hazardous air pollutants and volatile organic compounds.

3.1.1.1 Criteria Air Pollutants

EPA has established NAAQS for the five criteria air pollutants: CO, NO_2, ozone, PM, and SO_2. There are two different standards for particulate matter. Primary standards protect public health, while secondary standards protect public welfare (e.g., visibility, crops, forests, soils, and materials). Class 1 areas are locations where air quality is deemed especially sensitive such as national parks and wilderness areas and receive heightened protection under the Clean Air Act. There are a number of Class 1 areas in and near the TVA power service area (e.g., Mammoth Cave National Park).

Ambient air monitors measure concentrations of these pollutants to determine attainment with these standards. Areas where these measurements exceed the standards are designated as non-attainment areas. New emissions sources to be located in or near these areas are subject to more stringent air permitting requirements. Anderson and Roane counties in Tennessee, where BRF and KIF are located, are non-attainment for $PM_{2.5}$. Shelby County, Tennessee, where ALF is located, is in nonattainment for ozone. The State of Tennessee has filed a petition to have the area re-designated as attainment. All other coal-fired power plants are located in attainment areas for all of the NAAQS.

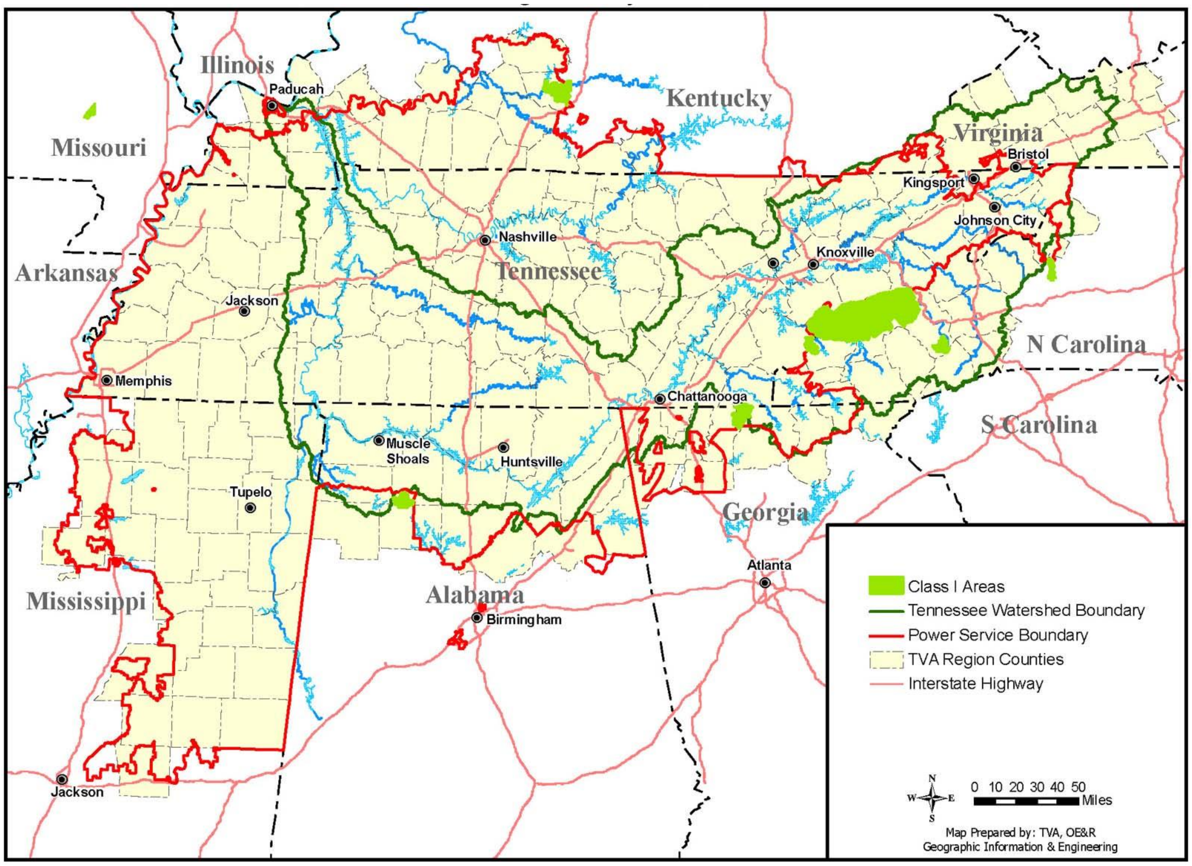

Figure 3-1. TVA Service Area and Class I Air Quality Areas

3.1.1.1.1 Sulfur Dioxide

SO_2 is a colorless gas with a sharp odor that can cause respiratory problems at high concentrations. SO_2 also combines with other elements to form sulfate, a secondary pollutant that contributes to acid deposition, regional haze and fine particle concentrations.

TVA's SO_2 emissions have decreased by 94 percent since 1974. This reduction is largely the result of TVA's installation of FGD systems on coal plants and recent coal plant retirements. Currently, all of TVA's coal-fired power plants are in SO_2 attainment areas.

3.1.1.1.2 Nitrogen Oxides

Nitrogen oxides (NO_x) are a group of highly reactive gases, including NO_2 that contain varying amounts of nitrogen and oxygen. NO_x emissions contribute to ground-level ozone, fine particulate matter, regional haze, acid deposition and nitrogen saturation. Natural sources of NO_x include lightning, forest fires and microbial activity; major sources of human-produced NO_x emissions include motor vehicles, electric utilities, industrial boilers, nitrogen fertilizers and agricultural burning.

Regional annual NO_x concentrations declined by 52 percent between 1979 and 2013 and by 63 percent since the peak concentration in 1988. Average regional concentrations are well below the NO_x annual NAAQS standard. Across the TVA system, NO_x emissions have been decreased by 91 percent since 1995. All TVA coal-fired power plants are located in NO_x attainment areas.

3.1.1.1.3 Ozone

Ozone is a gas that occurs both in the stratosphere (10 to 30 mi above the Earth's surface) and at ground level where it is the main ingredient of smog. While stratospheric ozone is beneficial due to its role in absorbing ultraviolet radiation, ground-level ozone is an air pollutant that can damage lung tissue and harms vegetation at sufficiently high concentrations. The ozone NAAQS applies to ground-level ozone. Ozone is a secondary pollutant which is not directly emitted by any source; it is formed by a chemical reaction between NO_x and volatile organic compounds (VOCs) in the presence of sunlight. Because ozone formation depends on sunlight, ozone concentrations are highest during the summer and greater in areas with hot summers, such as the southeastern United States.

In 2008, EPA lowered the 8-hour ozone standard from 80 parts per billion (ppb) to 75 ppb. Shelby County, Tennessee is currently designated in attainment with all of the NAAQS except ozone. The EPA has designated Shelby County as a non-attainment area for ozone based on 2008-2010 data. The State of Tennessee has filed a petition to have the area re-designated based on 2009-2011 data demonstrating attainment with the 2008 ozone NAAQS of 75 ppb. TVA plans to replace the coal-fired units at ALF, located in Shelby County, with combined cycle/combustion turbines which will reduce NOx and VOCs emissions significantly and could contribute to a reduction in ozone levels in the area (see Section 3.25, Cumulative Effects). On October 1, 2015, EPA lowered the 8-hour ozone standard to 70 ppb. 80 Fed Reg. 65292 (October 26, 2015). The effect of this action on attainment has yet to be fully determined.

3.1.1.1.4 Particulate Matter

PM consists of small solid "dust" particles or liquid droplets. PM is regulated by size class: PM less than 10 micrometers (µm) in diameter (PM_{10}), and PM less than 2.5 µm in diameter ($PM_{2.5}$).

Particles emitted directly from a pollution source are called primary particles, whereas those formed after emission—by the chemical and physical conversion of gaseous pollutants—are called secondary particles.

When inhaled by humans, large particles are filtered by the nose and throat, while fine particles can be drawn deeper into the lungs. Consequently, fine particles have more adverse health impacts. Exposure to high levels of fine particles can impact the respiratory and cardiovascular systems, particularly in elderly people and those with respiratory or cardiovascular disease.

PM has many natural and human-made sources. Natural sources include windblown dust, forest fires, volcanoes, and ocean spray, while human-made sources include motor vehicles, fossil-fuel combustion, industrial processes, mining, agricultural activities, waste incineration and construction.

Part of Anderson County and all of Roane County are classified as non-attainment for $PM_{2.5}$. TVA's BRF and KIF are located in these non-attainment areas. SO_2 (a precursor pollutant for $PM_{2.5}$) reductions across the TVA system should help these counties achieve attainment.

There are no non-attainment areas for PM_{10} in the TVA region.

3.1.1.1.5 Carbon Monoxide

Carbon monoxide (CO) is a colorless and odorless gas formed when carbon in fuel is not burned completely. At high concentrations, CO can aggravate heart disease and even cause death. Major CO sources include motor vehicles, off-road sources (i.e., construction equipment, airplanes and trains), metals processing and chemical manufacturing. The primary natural source of CO is wildfires. Electric utilities are not a major source of CO emissions and account for 1 percent of the total CO emissions in the United States. All counties within the TVA region are in attainment for CO.

3.1.1.2 Other Air Pollutants and Air Quality Concerns

Other pollutants that could affect air quality include hazardous air pollutants and volatile organic compounds.

3.1.1.2.1 Hazardous air pollutants (HAPs)

Hazardous air pollutants (HAPs) are toxic air pollutants, which are known or suspected to cause cancer or other serious health effects or adverse environmental effects. The CAA identifies 187 pollutants as HAPs. Most HAPs are emitted by human activity, including motor vehicles, factories, refineries and power plants.

3.1.1.2.2 Volatile organic compounds

VOCs are compounds that have a high vapor pressure (i.e., readily evaporate at ambient temperatures) and low solubility in water. The most common sources of man-made VOCs are petrochemical storage and transport, chemical processing, motor vehicles, paints and solvents. Natural sources of VOCs include vegetation, biological decay and forest fires. In many areas of the Southeast, natural sources contribute up to 90 percent of total VOCs. TVA does not emit a significant amount of VOC emissions. While VOCs are not a criteria pollutant, they are important because they are a precursor to ground-level ozone.

3.1.2 Environmental Consequences

3.1.2.1 Alternative A – No Action

Alternative A will involve no changes to the current conditions, and previously generated CCR will continue to be stored in the existing ash impoundments. No additional or new air quality impacts would be associated with this alternative. Current air quality in the vicinity of the ash impoundments is expected to be consistent with approved state air pollution implementation plans. Therefore, no significant impacts to air quality would occur with this alternative.

3.1.2.2 Alternative B – Closure-in-Place

Alternative B will involve several activities that potentially would result in air emissions. These activities include decanting of surface water, equipment removal, grading and compaction of CCR, transport of borrow material and installation of approved closure systems (see Section 2.2). For inactive impoundments within TVA's system, these activities would generally require less than two years for completion. Similar or longer durations may be required for closure activities for other ash impoundments. Relevant data on size, fill material quantities, number of dump trucks for hauling fill material per day are summarized in Table 2-1.

Potential air quality impacts from the decanting, compacting, filling in, contouring, installing cover system, and planting of vegetation include dust and emissions from equipment. Earth-moving activities (dozing, grading, and fill placement) and equipment movement on the on-site and off-site unpaved haul roads will be the principal sources of fugitive dust. This dust could affect particulate levels. Emissions from equipment that use diesel or gas as fuel may include particulates, CO, CO_2, HAPS, NO_x, ozone, SO_2 and VOCs. However, the total amount of these emissions would be temporary, small and would result in minimal off-site impacts. Air quality impacts from construction activities would be temporary and would be dependent upon both man-made factors (e.g., intensity of activity, control measures), and natural factors (e.g., wind speed, wind direction, soil moisture).

The amount of borrow/fill material required to cover these ash impoundment areas varies from less than 15,000 yd^3 to a high of 4,300,000 yd^3, with most requiring less than 150,000 yd^3.

The equipment that will be required for this alternative includes dozers (up to 10), compactors (up to five), dump trucks (up to 20), scrapers/pans (up to 10), track hoes (up to five), cranes and diesel pumps. With the exception of the dump trucks, the equipment will be used on-site and any air quality impacts would be limited to the immediate site area. However, up to 350 truck trips (175 trucks of 15 yd^3 capacity) per day would be traveling between the site and the borrow areas (some are on-site and others will be within 30 mi of the site) during the construction period. These dump trucks would operate both on-site and off-site.

It is estimated that the largest fraction (greater than 95 percent by weight) of fugitive dust emissions would be deposited within the construction site boundaries. The remaining fraction of PM would be subject to longer-range transport. TVA requires all contractors to keep construction equipment properly maintained and also to use BMPs (such as covered loads and watering unpaved haul roads) to minimize dust, if necessary. TVA power plants have fugitive dust control plans as required under existing Title V permits. In addition, the CCR Rule requires fugitive dust control plans. Closure activities will follow these fugitive dust control plans.

Notably, a recent study conducted by EPRI has evaluated the impact of impoundment closure on particulate emissions for a hypothetical CCR impoundment in Tennessee. Under a closure scenario similar to Alternative B, EPRI found that $PM_{2.5}$ and PM_{10} emissions exceeded the baseline condition and approached (but did not exceed) the NAAQS criterion for both the annual average and 24-maximum values (EPRI 2015c). Exceedances of applicable ambient air quality standards are not expected. It is expected therefore, that for all sites these emissions would have potential adverse short term local effects on air quality. Overall, regional impact on air quality is expected to be minor.

Additionally, new emission control technologies and fuel mixtures have significantly reduced vehicle and equipment emissions. As a result of the equipment maintenance requirements, use of BMPs by construction companies, and continued improvement of emission control measures and fuel blends, emission and dust impacts are expected to be reduced.

3.1.2.3 Alternative C – Closure-by-Removal

This alternative involves decanting of surface water, removal of CCR in accordance with state requirements, filling-in and contouring, and planting of vegetation. These activities may require from two years to 70 years to complete, depending on the amount of CCRs to be removed. The relevant data on size, quantities of CCR, and dump trucks required to remove the CCR each day are shown in Table 2-3.

Under this alternative, the amount of CCR that would have to be dewatered, excavated, and hauled to permitted landfills is large ranging from less than 145,500 to 25,000,000 yd^3. The CCR material transported off-site would be dried to a reasonable degree to support transport.

The quantity of dump trucks required to move this amount of material is potentially very large, and due to logistical considerations and the availability of equipment, it is likely that the large ash impoundments would require significantly more than two years for completion. Based on the estimates in Figure 2-7, the number of daily round-trip truck trips would have to increase from the estimated maximum of 350 per day for the closure-in-place alternative to transport borrow material, to several thousand per day for the larger impoundments to transport CCR and borrow material.

Under this alternative, borrow material also would have to be transported to the site similar to the process discussed for Alternative B. The types of impacts discussed for Alternative B are similar to these impacts but impact magnitude could be much greater based on the larger volumes of CCR and borrow material excavated and transported. BMPs, similar to those for Alternative B, will be implemented, as appropriate. In addition, permitted landfills receiving CCR will have fugitive dust plans to minimize air impacts from managing the CCR.

In the analysis of the closure of the hypothetical CCR impoundment in Tennessee, EPRI also evaluated the potential effects of a closure scenario similar to Alternative C. EPRI found that this scenario has a more negative impact than the Closure-in-Place alternative when considering both $PM_{2.5}$ and PM_{10}, likely due to the larger number of emission sources and the closer proximity of some emissions sources (roadways) to the residential community. $PM_{2.5}$ emissions markedly exceeded the baseline condition and approached (but did not exceed) the NAAQS criterion for both the annual average and 24-maximum values (EPRI 2015c). Exceedances of applicable ambient air quality standards are not expected. It is expected, therefore, that for all sites these emissions would have potentially notable and long term (depending on CCR volume) adverse local effects that would be greater than those evident under Alternative B.

3.2 Climate Change and Greenhouse Gases

3.2.1 Affected Environment

The average temperature in the United States has increased by 1.3°F to 1.9°F since record keeping began in 1895; most of this increase has occurred since about 1970. The most recent decade has been reported as the nation’s warmest on record, and temperatures in the United States are expected to again continue to rise. However, this increase has not occurred uniformly across the United States with the Southeast showing almost no increase. Because human-induced warming is superimposed on a naturally varying climate, the temperature rise has not been, and will not be, uniform or smooth across the country over time (Melillo et al. 2014). Globally, it appears that the temperature has not increased for almost 18 years based on satellite measurements.

The 2014 National Climate Assessment concluded global climate is projected to continue to change over this century and beyond. The amount of warming projected beyond the next few decades is directly linked by these studies to the cumulative global emissions of greenhouse gas and particulates. By the end of this century, the 2014 National Climate Assessment concluded a 3°F to 5°F rise can be projected under the lower emissions scenario and a 5°F to 10°F rise for a higher emissions scenario. As with all future scenario modeling exercises, there is an important distinction to be made between a "prediction" of what "will" happen and a "projection" of what future conditions are likely given a particular set of assumptions (Melillo et al. 2014).

The Southeastern United States is one of the few regions globally that does not exhibit an overall warming trend in surface temperature over the 20th century. This "warming hole" also includes part of the Great Plains and Midwest regions in the summer. Historically, temperatures increased rapidly in the Southeast during the early part of the 20th century, then decreased rapidly during the middle of the 20th century. Since the 1960s, temperatures in the Southeast have been increasing. Recent increases in temperature in the Southeast have been most pronounced in the summer season, particularly along the Gulf and Atlantic coasts. However, temperature trends in the Southeast over the period of 1895 to 2011 are found to be statistically insignificant for any season. Generally, in the Southeast, the number of extreme hot days has tended to decrease or remain the same while the number of very warm summer nights has tended to increase. The number of extreme cold days has tended to decrease. Global warming is a long-term trend, but that does not mean that every year will be warmer. Day-to-day and year-to-year changes in weather patterns will continue to produce variation, even as the climate warms. Generally, climate change results in Earth's lower atmosphere becoming warmer and moister, resulting in the potential for more energy for storms and certain severe weather events. Trends in extreme rainfall vary from region to region (Kunkel et al. 2013).

3.2.1.1 Natural Greenhouse Gas Emissions

The sun is the primary source of energy for the Earth's climate. About 30 percent of the sun's energy that reaches Earth is reflected back to space by clouds, gases and small particles in the atmosphere. The remainder is absorbed by the atmosphere and the surface. The Earth's temperature depends on the balance between the energy entering and leaving the planet's system. When energy is absorbed by the Earth's system, global temperatures increase. Conversely, when the sun's energy is reflected back into space, global temperatures decrease.

In nature, CO_2 is exchanged continually between the atmosphere, plants and animals through processes of photosynthesis, respiration and decomposition, and between the atmosphere and oceans through gas exchange. Billions of tons of carbon in the form of CO_2 are annually absorbed by oceans and living biomass (i.e., sinks) and are annually emitted to the atmosphere through natural and man-made processes (i.e., sources). When in equilibrium, carbon fluxes among these various global reservoirs are roughly balanced.

3.2.1.2 Greenhouse Effect

Similar to the glass in a greenhouse, certain gases, primarily CO_2, nitrous oxide (N_2O), methane (CH_4), hydroflurocarbons (HFCs), perflourocarbons (PFCs) and sulfur hexafluoride (SF_6), absorb heat that is radiated from the surface of the Earth. It is believed that increases in the atmospheric concentrations of these gases cause the Earth to warm by trapping more heat. The common term for this phenomenon is the "greenhouse effect," and these gases are typically referred to as GHGs. Atmospheric levels of CO_2 are currently increasing at a rate of 0.5 percent per year. Atmospheric levels measured at Mauna Loa in Hawaii and at other sites around the world reached 400 parts per million in 2013, higher than the Earth has experienced in over a million years.

While water vapor is the most abundant GHG in the atmosphere, it is not included in the list of GHGs because changes in the atmospheric concentration of water vapor are generally considered to be the result of climate feedbacks related to the warming of the atmosphere, rather than a direct result of human activity. That said, the impact of water vapor is critically important to projecting future climate change, and quantifying the effect of feedback loops on global and regional climate is the subject of ongoing data collection and active research.

The modeling projections of warming depend largely on the amount of GHG accumulating in the atmosphere. GHGs can remain in the atmosphere for different amounts of time, ranging from a few years to thousands of years. GHGs are assigned global warming potentials, a measure of the relative amount of infrared radiation they absorb, their absorbing wavelengths and their persistence in the atmosphere (Table 3-1). All of these gases remain in the atmosphere long enough to become well mixed, meaning the amount that is measured in the atmosphere is roughly the same all over the world, regardless of the source of the emissions.

Table 3-1. Major Man-Made Greenhouse Gases and Their Global Warming Potentials

Gas	Global Warming Potential
Carbon dioxide (CO_2)	1
Methane (CH_4)	28
Nitrous oxide (N_2O)	265
Hydroflourocarbons (HFCs)	4-12,400
Perfluorocarbons (PFCs)	6,630-11,100
Sulfur hexafluoride (SF_6)	23,500

Source: Intergovernmental Panel on Climate Change (IPCC) 2014

3.2.1.3 Greenhouse Gas Emissions

Electric utilities are one of the major emitters of CO_2 as a result of the combustion of coal, natural gas and other fossil fuels.

In 2013, worldwide man-made annual CO_2 emissions were estimated at 36 billion tons, with sources within the United States responsible for 14 percent of this total. U.S. electric utilities, in turn, emitted 2.039 billion tons in 2012, roughly 32 percent of the U.S. total. CO_2 emissions from TVA-owned generating facilities were 81,248,765 tons in 2012 and 72,154,380 tons in 2013; these accounted for about 4 percent of annual U.S. electric utility emissions (TVA 2015).

3.2.1.4 Climate Adaptation

TVA has, in accordance with the requirements of EO 13514 – Federal Leadership in Environmental, Energy, and Economic Performance and EO 13653 – Preparing the United States for the Impacts of Climate Change, adopted a climate adaptation plan that establishes adaptation planning goals and describes the challenges and opportunities a challenging climate may present to its mission and operations. The goal of TVA's adaptation planning process is to ensure that TVA continues to achieve its mission and program goals and to operate in a secure, effective and efficient manner in a changing climate.

TVA manages the effects of climate change on its mission, programs and operations within its environmental management processes. TVA's Environmental Policy provides objectives for an integrated approach related to providing cleaner, reliable and affordable energy, supporting sustainable economic growth and engaging in proactive environmental stewardship. The policy includes the specific objective of stopping the growth in volume of emissions and reducing the rate of carbon emissions by 2020 by supporting a full slate of reliable, affordable, lower-CO_2 energy-supply opportunities and energy efficiency.

3.2.2 Environmental Consequences

3.2.2.1 Alternative A – No Action

Alternative A will involve no changes to the current conditions at the existing ash impoundments. Operation and maintenance activities would continue to generate small amounts of climate and GHGs from equipment and vehicles used in operation and maintenance of the ash impoundments. However, because such emissions are negligible, no changes to climate will occur.

3.2.2.2 Alternative B – Closure-in-Place

Changes to climate and GHGs can result from the discharge of large quantities of heat, moisture, CO_2 and NO_x to the atmosphere. GHG emissions associated with this alternative relate to the emissions produced in conjunction with composite liner construction and the operation of combustion engine equipment during construction.

The equipment and vehicles that will be required for this alternative includes dozers (up to 10), compactors (up to five), dump trucks (up to 20), scrapers/pans (up to 10), track hoes (up to five), cranes, and diesel pumps per site. Relevant construction data for this alternative are summarized in Table 2-1. Emissions from this equipment will include heat, moisture, CO_2, and potentially NO_x.

Notably, a recent study conducted by EPRI has evaluated the impact of impoundment closure on GHG emissions for a hypothetical CCR impoundment in Tennessee. Under a closure scenario similar to Alternative B, EPRI found that the largest negative impacts are from increased NO_x emission and total energy used. In all cases the difference between the scenario similar to Alternative B (in-place closure) and the scenario similar to Alternative C (excavate and redispose) is significant for all Green and Sustainable Remediation metrics; the negative impacts of excavate and redispose are about 10-fold greater than in-place closure (EPRI 2015c).

However, these impacts are expected to be comparatively small, and temporary. Therefore, no changes to climate or significant increases in greenhouse gases are anticipated.

3.2.2.3 Alternative C – Closure-by-Removal

This alternative will use the same types of equipment and vehicles as Alternative B, only in greater quantities because of excavation and transport of CCR material to a permitted on-site or off-site landfill. Construction duration will be increased due to time needed to excavate CCR from impoundments. It is anticipated that grading efforts and borrow material transport will be similar to those efforts for Alternative B.

In the analysis of the closure of the hypothetical CCR impoundment in Tennessee EPRI also evaluated the potential effects of a closure scenario similar to Alternative C. EPRI found that this scenario results in significantly greater GHG emissions than the in-place closure scenario (EPRI 2015c).

While this alternative will use more equipment for extended periods of time, associated impacts would be small and temporary. Therefore, no changes to climate or significant increases in greenhouse gases are anticipated.

3.3 Land Use

3.3.1 Affected Environment

Major land uses in the TVA region include forestry, agriculture, and urban/suburban/ industrial (U.S. Department of Agriculture [USDA] Natural Resources Conservation Service [NRCS] 2013). Of the non-Federal land area, about 12 percent is classified as developed and 88 percent as rural. Rural undeveloped lands include farmlands (28 percent of the rural area) and forestland (about 60 percent of the rural area). High rates of urban and suburban growth since 1982 have caused a large increase in developed lands within the TVA region. As a result, both cropland and pastureland have decreased in area since 1982 (USDA NRCS 2013).

Approximately 53 percent of the TVA region is forested (USFS 2014). Forestland is predicted to decrease between 1992 and 2020 in the majority of counties in the TVA region, with several counties in the vicinity of Memphis, Nashville, Huntsville, Chattanooga, Knoxville and the Tri-Cities area of Tennessee predicted to lose more than 10 percent of forest area (Wear et al. 2007). Most of the TVA region in Mississippi, as well as some rural parts of Tennessee and Kentucky are predicted to show little change or a small increase in forestland by 2020. About 97 percent of the forestland in the TVA region is classified as timberland (USFS 2014), forestland that is producing or capable of producing more than 20 cubic feet of merchantable wood per acre per year and is not withdrawn from timber harvesting by law.

Agriculture is a major land use and industry in the TVA region. In 2012, 41 percent, almost half of the farmland (47.0 percent), was classified in 2012 as cropland, which includes hay and short-rotation woody crops (USDA NRCS 2013). A quarter (24.6 percent) of the farmland was pasture and the remainder was woodland or devoted to other uses such as buildings and other farm infrastructure.

Land use associated with TVA coal-fired power plants is predominately industrial and classified as high intensity developed and developed open space. Other land cover types within the facilities include open water (impoundments) and barren land. Land surrounding the facilities that are also owned by TVA include a variety of undeveloped land uses with varying cover types, including forest, old fields, and ruderal/early-successional.

3.3.2 Environmental Consequences

3.3.2.1 Alternative A – No Action

Under Alternative A, TVA will not close any of the ash impoundments; therefore there would be no change in land use.

3.3.2.2 Alternative B – Closure-in-Place

Under Alternative B, ash impoundments will be closed in-place with an approved cover system (see Section 2.2) using borrow material from a previously permitted site. Since most of the lands within the project area are considered to be previously developed, the resulting land use of the site is consistent with the current use of the site. Closure of the ash impoundments would convert the existing impoundment from open water to an area with terrestrial land cover. However, this area would still be located within the TVA plant site and be used for industrial purposes; therefore closure of the ash impoundment would not result in the conversion of any land uses. Additionally, borrow material would be obtained from a permitted site and, therefore, would have no secondary impacts on land use at that site. Therefore, no changes in land use would occur with this alternative.

Lands expected to be used for construction-related activities would be located within the existing TVA facility property. Short-term impacts would include the temporary conversion of the some vacant areas to laydown areas to support various construction-related activities (i.e., vehicle and equipment parking, storage, and construction administration). Upon completion of construction activities, it is anticipated that these areas would be restored to their previous condition and use.

3.3.2.3 Alternative C – Closure-by-Removal

Land use impacts associated with closure activities under Alternative C would be similar to those identified under Alternative B. As with Alternative B, construction activities associated with impoundment closure and the transport of CCR to either an on-site or off-site landfill would not impact the land use at the disposal site as this would be a previously permitted and developed facility. Additionally, borrow material would be obtained from a permitted site and, therefore, would have no secondary impacts on land use at that site. However, under this alternative there would be a broader range of future land use options at these sites as impoundments closed-by-removal would not be subject to future restrictions under the CCR Rule and these lands may be available for future industrial or non-industrial use. However, all of the impoundments are located in areas developed for industrial use which does limit future non-industrial use options for these sites.

3.4 Prime Farmland

3.4.1 Affected Environment

Various state laws and local ordinances regulate land use, although a large portion of land in the TVA region is not subject to local zoning ordinances. The 1981 Farmland Protection Policy Act (7 CFR Part 658) requires all federal agencies to evaluate impacts to prime and unique farmland prior to permanently converting to land use incompatible with agriculture. Prime farmland soils have the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops. These characteristics allow prime farmland soils to produce the highest yields with minimal expenditure of energy and economic resources. In general, prime farmlands have an adequate and dependable water supply, a favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content and few or no rocks. Prime farmland soils are permeable to water and air, not excessively erodible or saturated for extended period and are protected from frequent flooding.

Farms in the TVA region produce a large variety of products that varies across the region. While the proportion of land in farms is greatest in Mississippi, southern Kentucky, and central and western Tennessee, the highest farm income occurs in northern Alabama and Georgia (EPRI and TVA 2009). Region-wide, the major crop items by land area are forage crops (hay and crops grown for silage), soy, corn and cotton. The major farm commodities by sales are cattle and calves, poultry and eggs, grains and beans, cotton and nursery products (NRCS 2013).

Approximately 22 percent of the TVA region is classified as prime farmland (NRCS 2014). An additional 4 percent of the TVA region would be classified as prime farmland if drained or protected from flooding.

Lands owned by TVA as agent for the United States and operated in conjunction with coal-fired power plant sites are typically located on river terrace and floodplain landscapes along major river systems. Soils within such landscapes are often characterized as prime or unique farmland or farmland of statewide importance because of their improved fertility, drainage and capacity to support agricultural production. Although the soils within a given project area may have the physical characteristics of prime farmland, lands at sites that have been dedicated to industrial uses are administratively removed from the prime farmland category under the Farmland Protection Policy Act and its implementing regulations.

3.4.2 Environmental Consequences

3.4.2.1 Alternative A – No Action

Since there would be no conversion of farmland to other uses, no impacts to prime farmland would occur.

3.4.2.2 Alternative B – Closure-in-Place

Actions associated with Alternative B may occur on project sites having soils with prime farmland characteristics. However the project area and laydown areas are typically highly disturbed features of plant sites and are not expected to exhibit prime farmland soil characteristics. Additionally, these areas are dedicated to industrial uses and are, therefore, exempt from regulation. Since borrow material used to close the impoundments would be obtained from a previously permitted site, there would be no additional secondary impact to lands with prime farmland soils.

3.4.2.3 Alternative C – Closure-by-Removal

Prime farmland impacts associated with closure activities under Alternative C would be the same as identified under Alternative B. The permitted disposal site would be zoned or dedicated to an industrial use and would not be considered prime farmland. Therefore, there would be no impacts to prime farmland resulting from implementation of Alternative C.

3.5 Geology and Seismology

3.5.1 Affected Environment

3.5.1.1 Regional Geology

The TVA region encompasses portions of five major physiographic provinces and six smaller physiographic sections (Figure 3-2) (Table 3-2) (Fenneman 1938, Miller 1974). Physiographic provinces and sections are areas of similar land surfaces resulting from similar geologic history.

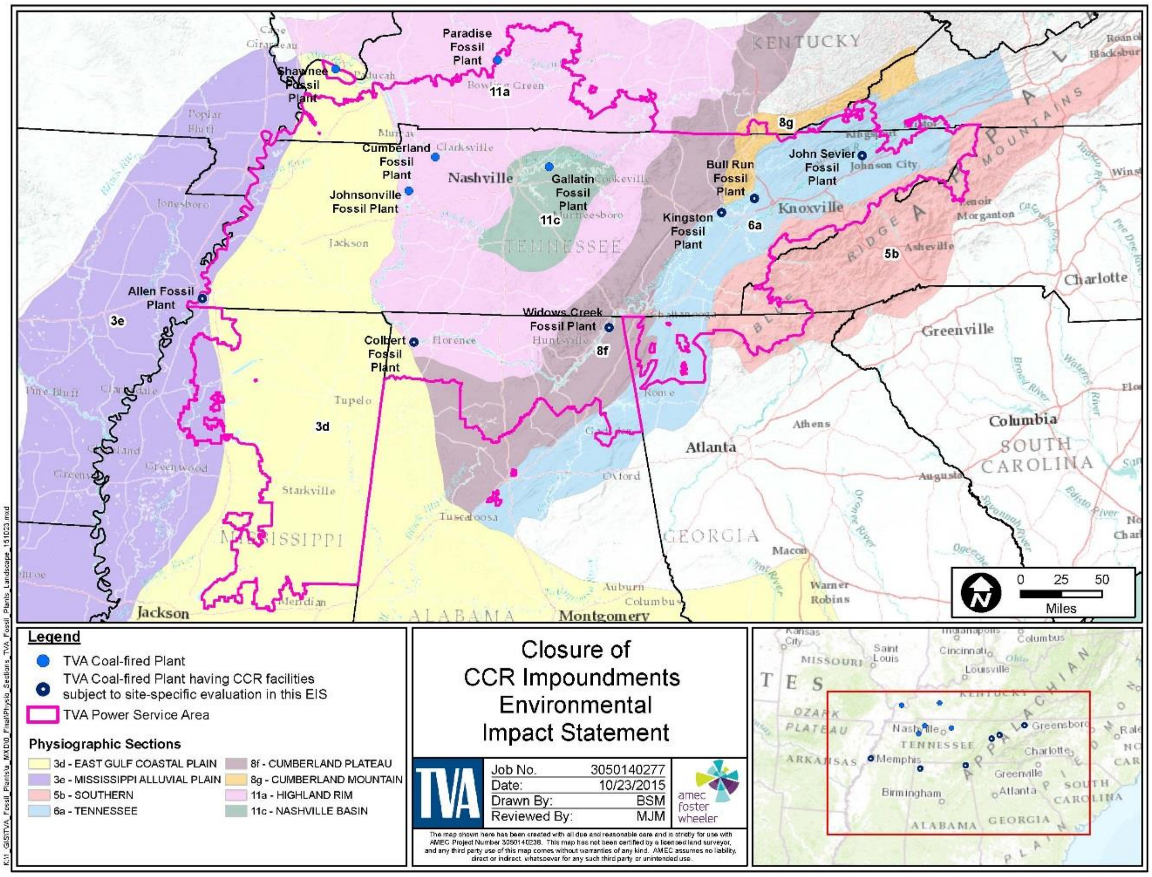

Figure 3-2. Physiographic Sections of the TVA Region (Adapted from Fenneman, 1938

Table 3-2. Summary of Geologic Characteristics at TVA Coal-Fired Power Plants

Plant Name	Physiographic Province	Bedrock	Landscape Position	Overlying Soils	Source
ALF	Coastal Plain	Alluvium	River Terrace	Alluvium	Stantec 2010b
BRF	Valley and Ridge	Chickamauga Formation	River Terrace	Alluvium	URS 2012
COF	Interior Low Plateaus	Tuscumbia Limestone	River Terrace	Alluvium	Stantec 2010a
CUF	Interior Low Plateaus	Various Cambrian to Mississippian strata: meteorite impact structure	River Terrace	Alluvium	TVA 2015
GAF	Interior Low Plateaus	Bigby-Cannon Limestone, Hermitage Formation, Carters limestone, Lebanon limestone	River Terrace	Alluvium	Dewberry Consultants 2013
KIF	Valley and Ridge	Conasauga Shale/Rome Formation	River Terrace	Alluvium	Benziger and Kellberg 1951, AECOM 2009
PAF	Interior Low Plateaus	Sturgis and Carbondale Formations	River Terrace	Alluvium	Stantec 2009c
JOF	Interior Low Plateaus	Chattanooga Shale, Camden Formation	River Terrace	Alluvium	Stantec 2010e
JSF	Valley and Ridge	Sevier Shale	River Terrace	Alluvium	Stantec 2010c
SHF	Coastal Plain	Clayton and McNairy Formations	River Terrace	Alluvium and loess	Stantec 2009a
WCF	Appalachian Plateau	Sequatchie Formation, Nashville Group and Stone River Group	River Terrace	Alluvium	TVA 2013

The easternmost part of the region is in the Blue Ridge physiographic province (Southern section), an area composed of the remnants of an ancient mountain chain. This province has the greatest variation in terrain in the TVA region. Terrain ranges from nearly level along floodplains at elevations of about 1,000 ft to rugged mountains that reach elevations of more than 6,000 ft. The rocks of the Blue Ridge have been subjected to much folding and faulting and are mostly shales, sandstones, conglomerates, and slate (sedimentary and metamorphic rocks of Precambrian and Cambrian age. No TVA coal-fired plants are located within this province.

The Valley and Ridge province (Tennessee section) is located west of the Blue Ridge province and includes lands containing the JSF, KIF, and BRF plants. The province has complex folds and faults with alternating valleys and ridges trending northeast to southwest. Ridges have elevations of up to 3,000 ft and are generally capped by dolomites and resistant sandstones, while valleys have developed in more soluble limestones and dolomites. The dominant soils in this province are residual clays and silts derived from *in-situ* weathering. Karst features such as sinkholes and springs are numerous in the Valley and Ridge province. “Karst” refers to a type of topography that is formed when rocks with a high carbonate content, such as limestone and dolomite, are dissolved by groundwater to form sink holes, caves, springs and underground drainage systems.

The Appalachian Plateau province is an elevated area west of the Valley and Ridge province and is comprised of the extensive Cumberland Plateau section and the smaller Cumberland Mountain section. WCF is the only TVA coal-fired generating station in this province. The Cumberland Plateau rises about 1,000 to 1,500 ft above the adjacent provinces and is formed by layers of near horizontal Pennsylvanian sandstones, shales, conglomerates and coals, underlain by Mississippian and older shale and limestones. The sandstones are resistant to erosion and have produced a relatively flat landscape broken by stream valleys. Toward the northeast, the Cumberland Mountain section is more rugged due to extensive faulting and has several peaks that exceed 3,000 ft in elevation. The province has a long history of coal mining and encompasses the Appalachian coal field (U.S. Geological Survey [USGS] 1996).

Two sections of the Interior Low Plateau province occur in the TVA region. The Highland Rim section includes CUF, COF and PAF and is a plateau that occupies much of central Tennessee and parts of Kentucky and northern Alabama. The bedrock of the Highland Rim is Mississippian limestones, chert, shale, and sandstone. The terrain varies from hilly to rolling to extensive, relatively flat areas in the northwest and southeast. The southern end of the Illinois Basin coal region (USGS 1996) overlaps the Highland Rim in northwest Kentucky and includes part of the TVA region. The Nashville Basin (also known as the Central Basin) section includes GAF and is an oval area in middle Tennessee with an elevation about 200 ft below the surrounding Highland Rim. The bedrock is limestones that are generally flat-lying. Soil cover is usually thin and surface streams cut into bedrock. Karst is well developed in parts of both the Highland Rim and the Nashville Basin.

The Coastal Plain province and the Mississippi Alluvial Plain section encompasses much of the western and southwestern TVA region and includes both SHF and ALF plants (Figure 3-2). Most of the Coastal Plain portion of the TVA region is in the extensive East Gulf Coastal Plain section. The underlying geology is a mix of poorly consolidated gravels, sands, silts and clays. Soils are primarily of windblown and alluvial (deposited by water) origin, low to moderate fertility and easily eroded. The terrain varies from hilly to flat in broad river bottoms. The Mississippi Alluvial Plain section occupies the western edge of the TVA region and much of the historic floodplain of the Mississippi River. Soils are deep and often poorly drained. The New Madrid Seismic Zone, an area of large prehistoric and historic earthquakes, is in the northern portion of the section.

Geologic hazards within the TVA operating area specifically associated with subsurface materials may include acidic soils, liquefiable soils, landslides, expansive soils, radon gas accumulation, and karst development or propagation. Each physiographic region’s specific conditions should be considered when evaluating the hazard risk at a particular facility.

3.5.1.2 Regional Seismic Setting

Section 257.63 of the CCR Rule defines a seismic impact zone as “an area having a 2 percent or greater probability that the maximum expected horizontal acceleration, expressed as a percentage of the earth’s gravitational pull (g) will exceed 0.10 g in 50 years.” Figure 3-3 is a graphical representation of the 2014 National Seismic Hazard Map for TVA region. As summarized in Table 3-3, each of TVA’s coal-fired facilities are located in areas where the expected Peak Ground Acceleration (PGA) is of 0.1 g or greater.

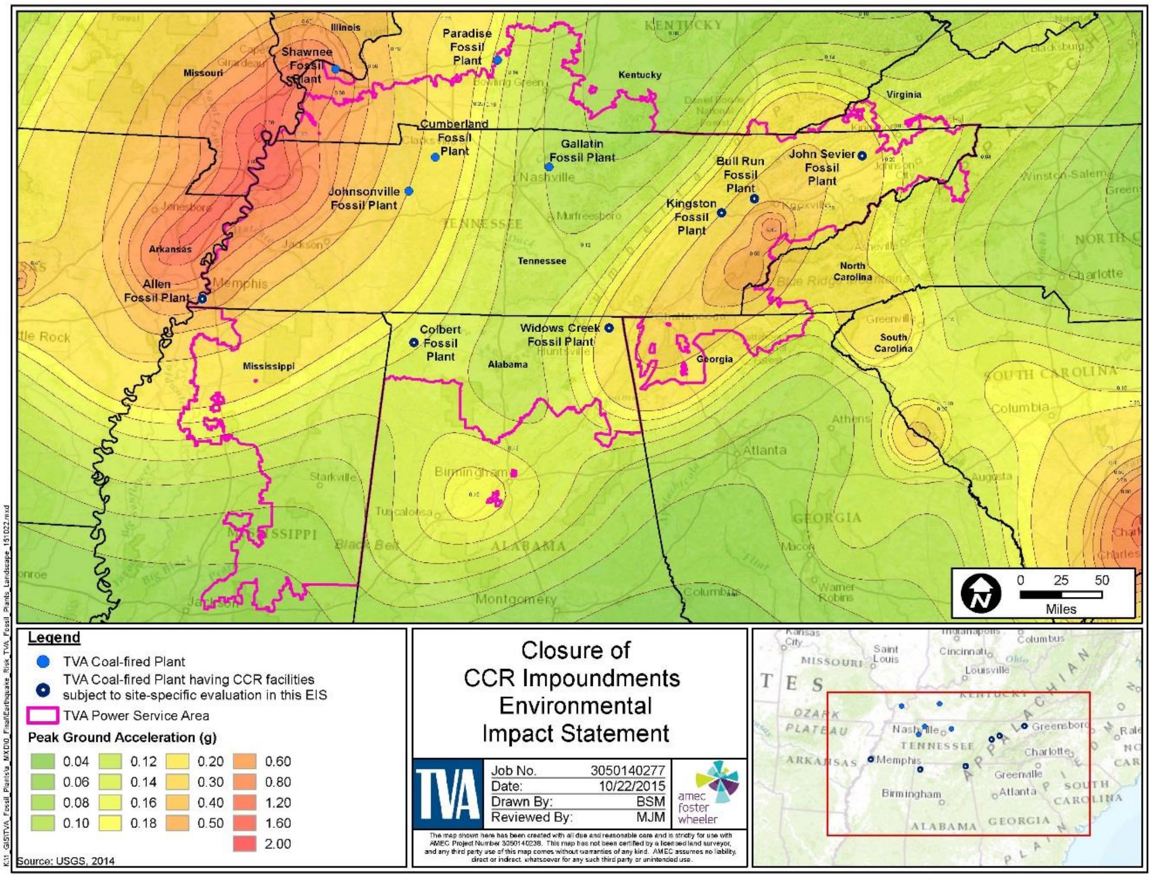

Figure 3-3. Seismic Peak Ground Acceleration Factors in the Vicinity of TVA Coal-Fired Plants

Table 3-3. PGA Values at TVA Coal-Fired Facilities

Plant	Peak Ground Acceleration (PGA)[1]	Seismic Zone
ALF	0.5 to 0.6	NMSZ
BRF	0.3 to 0.4	NMSZ, SASZ, SCSZ
COF	0.16 to 0.18	NMSZ, SASZ, SCSZ
CUF	0.2 to 0.3	NMSZ
GAF	0.1 to 0.12	NMSZ, SASZ
JOF	0.2 to 0.3	NMSZ
JSF	0.2 to 0.3	NMSZ, SASZ, SCSZ
KIF	0.3 to 0.4	NMSZ, SASZ, SCSZ
PAF	0.16 to 0.18	NMSZ, WVSZ
SHF	0.6 to 0.8	NMSZ
WCF	0.2 to 0.3	NMSZ, SASZ, SCSZ

Seismic zones of influence from Stantec, 2009a,b,e
[1]Expressed as a fraction of standard gravity (g).
NMSZ = New Madrid Seismic Zone
SASZ = South American Shear Zone
SCSZ = Sandhill Corner Shear Zone
WVSZ = Wabash Valley Seismic Zone

ALF, COF, CUF, JOF, SHF and PAF are expected to experience from 0.14 g to 0.8 g PGA, and these plants fall within the influence of the New Madrid Seismic Zone (NMSZ). GAF is in a comparatively quiet seismic zone between the NMSZ and the East Tennessee Seismic Zone (ETSZ), but is nevertheless expected to undergo from 0.1 g to 0.14 g PGA, as projected by the USGS data. BRF, KIF, JSF and WCF are situated in an area influenced by the ETSZ, with projections of potential PGA values ranging from 0.2 g to 0.4 g.

The PGA values for the 2014 USGS map are provided for a reference soft rock condition and values are adjusted based on site classification (hard rock, rock, dense soil/hard rock, etc.).

For sites that lie within zones that exceed 0.1 g, or for which adjusted values based on site conditions exceed 0.1 g, additional analysis is required to demonstrate that all structural components are designed to withstand seismic events. Site-specific data that are typically gathered to support additional analysis (if required) include geotechnical data that characterizes subsurface materials at the site (e.g., stratigraphic information from borings, shear-wave and compressional velocity data, and lithologic) and geophysical data from nearby deep wells.

An integral component of the seismic setting for a given facility must consider the presence and characteristics of faults. The regulatory requirement regarding faulting specifies that a setback distance of 200 ft is required from the outermost damage zone of a modern era (Holocene Era) fault (EPA 2015). A fault means “a fracture or a zone of fractures in any material along which strata on one side have been displaced with respect to that on the other side.” This definition encompasses both tectonic faults (i.e., formed as a result of deep-seated, crustal scale tectonic processes) and associated secondary faulting, and non-tectonic faults (i.e., those formed as a result of shallow crustal or surficial processes). Non-tectonic faults, which are driven predominantly by gravitational forces, include those produced by slope failure processes (e.g., landslides), dissolution phenomena (e.g., karst collapse), evaporite migration (e.g., salt domes and salt flowage), volcanism (e.g., dike-emplacement and caldera collapse), sediment compaction (e.g., growth faults, subsidence) and unloading phenomena (e.g., pop-ups). Hanson et al. (1999) provides detailed discussions of the characteristics of both tectonic and non-tectonic faults and criteria to differentiate tectonic and non-tectonic surface deformation and to identify active blind faults.

An understanding of the general geologic and tectonic setting of the site, both at regional as well as local scale, provides important contextual information to evaluate the potential for Holocene faulting at sites subject to ash impoundment closure. Key data sources important in evaluating the complexity of the surface and subsurface conditions may include:

- Geologic maps showing known or inferred faults,
- The Quaternary fault and fold database maintained by the USGS,
- Site-specific geotechnical reports, and
- Web-based searches to identify recent or ongoing research related to active faulting in the vicinity of the site.

3.5.1.3 Static Stability of Ash Impoundment Berms

The static stability of all existing or new impoundment structures is an important consideration to ensure that berms have integrity and represent a low risk of failure.

Potential instability under static conditions has important implications on the selection of the appropriate alternative for impoundment closure and the identification of mitigative measures to enhance static stability.

Typical considerations based on the CCR Rule (EPA 2015, Section 257.64, Unstable Areas) include site soil conditions that may result in significant differential settling. Conditions may also include local geologic or geomorphic features in addition to human made features or events. TVA has evaluated all of their ash impoundments within their system and they are static stable under the designed loads.

3.5.2 Environmental Consequences

3.5.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, no additional CCR will be managed in these impoundments except for those that would be needed to temporarily manage CCR during the transition to dry ash storage. No closure activities (i.e., no decanting of surface water or cover system construction) would occur under the No Action Alternative. However, the impoundments will continue to receive storm water and other process wastewaters. TVA will continue safety inspections of berms to maintain stability and all impoundments will be subject to continued care and maintenance activities.

In cooperation with EPA, TVA has evaluated the static stability of all impoundments at existing coal-fired power plants and has confirmed their stability under existing conditions (http://www3.epa.gov/epawaste/nonhaz/industrial/special/fossil/surveys2/index.htm). TVA is also currently investigating seismic stability for all of its ash impoundments. Any identified deficiencies or unacceptable seismic risks at existing ash impoundments will be addressed through appropriate mitigative measures that may include rock toe, soil berm construction, and concrete/steel pile installation, or other measures, as appropriate.

Due to the eventual elimination of sluicing of CCR materials as TVA converts from wet CCR management systems to dry systems, the hydraulic influx to the subsurface beneath the impoundments would be reduced. Consequently, the static stability of the impoundments would remain the same or be slightly improved. Similarly, the seismic factor of safety would remain the same or be slightly higher due to the suspension of the hydraulic influx of materials into the existing ponds.

Consequently, this alternative is expected to result in a marginal improvement of both static and seismic safety factors associated with the existing ash impoundments relative to the operational condition in which ash impoundments received CCR materials.

3.5.2.2 Alternative B – Closure-in-Place

Structural integrity criteria for existing CCR surface impoundments (EPA 2015, Section 257.73(e) of the Rule), establishes guidelines for conducting initial and periodic static, seismic, and liquefaction safety factor assessments. If an impoundment can be configured to meet the liquefaction safety factor requirements by discontinuing CCR placement, decanting of surface water and covering with a relatively impermeable barrier, geology in the vicinity of the impoundment would not be affected.

In cooperation with EPA, TVA has evaluated the static stability of all impoundments at existing coal-fired facilities and has confirmed their stability under existing conditions (http://www3.epa.gov/epawaste/nonhaz/industrial/special/fossil/surveys2/index.htm). TVA is also currently investigating seismic stability for all of its ash impoundments. Any identified deficiencies or unacceptable seismic risks at existing ash impoundments will be addressed through appropriate mitigative measures that may include rock toe, soil berm construction, and concrete/steel pile installation, or other measures, as appropriate.

Under this alternative, impoundments will be decanted to allow for consolidation of CCR materials and the installation of a low permeability closure system. As indicated in the CCR Rule (EPA 2015), decanted CCR surface impoundments will no longer be subjected to hydraulic head so the risk of releases, including the risk that CCRs will leach into the groundwater, would be no greater than those from CCR landfills. Therefore, it is expected that both the static and seismic factor of safety would be increased for all decanted impoundments under this alternative.

Impacts of this alternative associated with geological and seismic considerations are therefore positive relative to the No Action Alternative.

3.5.2.3 Alternative C – Closure-by-Removal

Under this alternative, impoundments will be decanted and all CCR materials will be excavated and transported to existing permitted disposal facilities. Existing berms will either be graded and removed or abandoned.

No impacts or risks of failure would occur at the removal site from geological and seismic considerations with this alternative.

3.6 Groundwater

3.6.1 Affected Environment

3.6.1.1 Regulatory Framework for Groundwater

The Safe Drinking Water Act of 1974 established the sole source aquifer protection program which regulates certain activities in areas where the aquifer (water-bearing geologic formations) provides at least half of the drinking water consumed in the overlying area. No sole source aquifers exist in the TVA region (USEPA 2015a).

This act also established the Wellhead Protection Program, a pollution prevention and management program implemented by each state, used to protect underground sources of drinking water and the Underground Injection Control Program to protect underground sources of drinking water from contamination by fluids injected into wells. Several other environmental laws contain provisions aimed at protecting groundwater, including RCRA, the Comprehensive Environmental Response, Compensation and Liability Act and the Federal Insecticide, Fungicide, and Rodenticide Act.

The CCR Rule also establishes groundwater protection requirements. The final provisions of 40 CFR §257.60 require owners or operators of an active CCR surface impoundment to demonstrate that the unit meets the minimum requirements for placement above the “uppermost aquifer” no later than October 17, 2018. This time frame was set to allow owners and operators time to adequately study and characterize seasonal variations in the elevation of the top of the uppermost aquifer. Owners and operators must initiate closure of those units that fail to make this demonstration no later than six months from this determination, except in limited circumstances as discussed in the rule.

For clarity, EPA revised the definition of "uppermost aquifer" to specify that the measurement of the upper limit of the aquifer must be made at a point nearest to the natural ground surface to which the aquifer rises during the wet season (EPA 2015c). As specified under 40 CFR §257.60(a), EPA is requiring owners or operators of active impoundments to demonstrate that there will not be an intermittent, recurring, or sustained hydraulic connection between any portion of the base of the impoundment unit and the uppermost aquifer due to normal fluctuations in groundwater elevations (including groundwater elevations during the wet season).

What is the "Uppermost Aquifer"?

EPA defined this term to mean "the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers that are hydraulically interconnected with this aquifer within the facility's property boundary." (EPA 2015c, p. 21471)

The term "potentiometric surface" is often used to describe the elevation of the groundwater table. However, local site-specific hydrogeologic conditions or other factors within the aquifer system may cause the potentiometric surface to vary.

The CCR Rule allows for the differentiation of the uppermost aquifer from usable groundwater. At 40 CFR §257.60(a), the term uppermost aquifer is defined as including a shallow, deep, perched, confined or unconfined aquifer, provided it yields usable water, which may include considerations of water quality and yield. TVA will take into account state-specific interpretations of usable groundwater as it evaluates the depth to the uppermost aquifer at each of its sites.

For ash impoundments that actively receive CCR materials via sluicing, storm water and other process wastewaters, it may be difficult to determine the natural gradient of the uppermost aquifer as groundwater mounding beneath the ash impoundments may be encountered.

What is "Groundwater Mounding"?

Groundwater mounding is the local rise of the water table above its natural level resulting from a localized hydrologic input above the natural groundwater level. The shape and height of the mound depend on several factors including the recharge rate, hydraulic conductivity and thickness of the aquifer in the area.

3.6.1.2 Regional Aquifers

Three basic types of aquifers occur in the TVA region:

- Unconsolidated sedimentary sand
- Carbonate rocks
- Fractured non-carbonate rocks

Unconsolidated sedimentary sand formations, composed primarily of sand with lesser amounts of gravel, clay and silt, constitute some of the most productive aquifers. Groundwater movement in sand aquifers occurs through the pore spaces between sediment particles.

Carbonate rocks are another important class of aquifers. Carbonate rocks, such as limestone and dolomite, contain a high percentage of carbonate minerals (e.g., calcite) in the rock matrix. Carbonate rocks in some parts of the region readily transmit groundwater through enlarged fractures (cracks) and cavities created by dissolution of carbonate minerals by acidic groundwater.

Fractured non-carbonate rocks represent the third type of aquifer found in the region. These aquifers include sedimentary and metamorphic rocks (e.g., sandstone and granite gneiss), which transmit groundwater through fractures and openings in the bedrock.

In the TVA region, groundwater derived from carbonate rocks of the Valley and Ridge, Highland Rim and Nashville Basin is generally slightly alkaline and high in dissolved solids and hardness. Groundwater from mainly noncarbonated rocks of the Blue Ridge, Appalachian Plateaus and Coastal Plain typically exhibits lower concentrations of dissolved solids compared to carbonate rocks. However, sandstones interbedded with pyritic shales often produce acidic groundwater high in dissolved solids, iron and hydrogen sulfide. These conditions are commonly found on the Appalachian Plateaus and in some parts of the Highland Rim and Valley and Ridge (Zurawski 1978). The chemical quality of most groundwater in the region is within health-based limits established by the EPA for drinking water.

For the purpose of the programmatic approach, the assumption can be made that groundwater flow direction is reflective of site topography and local geology and is anticipated to discharge to the adjacent river systems as described in the site-specific reports.

3.6.1.3 Groundwater Use

Groundwater data are compiled by the U.S. Geological Survey (USGS) and cooperating state agencies in connection with the national public water use inventory conducted every five years (Bohac and Bowen 2012). The largest use of groundwater is for public water supply. Almost all of the water used for domestic supply and 66 percent of water used for irrigation in the TVA region is groundwater. Groundwater is also used for industrial and mining purposes. The use of groundwater to meet public water supply needs varies across the TVA region and is the greatest in West Tennessee (TVA 2015b).

Eight major aquifers occur in the TVA region (Table 3-4). These aquifers generally align with the major physiographic divisions of the region. The aquifers include (in order of increasing geologic age):

- Quaternary age alluvium occupying the floodplains of major rivers, notably the Mississippi River
- Tertiary and Cretaceous age sand aquifers of the Coastal Plain Province
- Pennsylvanian sandstone units found mainly in the Cumberland Plateau section Carbonate rocks of Mississippian, Silurian and Devonian age of the Highland Rim section;
- Ordovician age carbonate rocks of the Nashville Basin section;
- Cambrian-Ordovician age carbonate rocks within the Valley and Ridge Province;
- Cambrian- Precambrian metamorphic and igneous crystalline rocks of the Blue Ridge Province.

Table 3-4. Aquifer, Well and Water Quality Characteristics in the TVA Region

Aquifer Description	Well Characteristics (common range, maximum)		Water Quality Characteristics
	Depth (ft)	Yield (gpm)	
Quaternary alluvium: Sand, gravel and clay. Unconfined	10 to 75, 100	20 to 50, 1,500	High iron concentrations in some areas.
Tertiary sand: Multi-aquifer unit of sand, clay, silt and some gravel and lignite. Confined; unconfined in the outcrop area.	100 to 1,300, 1,500	200 to 1,000, 2,000	Problems with high iron concentrations in some places.
Cretaceous sand: Multi-aquifer unit of interbedded sand, marl and gravel. Confined; unconfined in the outcrop area.	100 to 1,500, 2,500	50 to 500, 1,000	High iron concentrations in some areas.
Pennsylvanian sandstone: Multi-aquifer unit, primarily sandstone and conglomerate, interbedded shale and some coal. Unconfined near land surface, confined at depth.	100 to 200, 250	5 to 50, 200	High iron concentrations are a problem; high dissolved solids, sulfide or sulfate are problems in some areas.
Mississippian carbonate rock: Multi-aquifer unit of limestone, dolomite and some shale. Water occurs in solution and bedding-plan openings. Unconfined or partly confined near land surface; may be confined at depth.	50 to 200, 250	5 to 50, 400	Generally hard; high iron, sulfide, or sulfate concentrations are a problem in some areas.
Ordovician carbonate rock: Multi-aquifer unit of limestone, dolomite and shale. Partly confined to unconfined near land surface.	50 to 150, 200	5 to 20, 300	Generally hard; some high sulfide or sulfate concentrations in places.

Approximately 60 percent of all groundwater withdrawals in 2010 were supplied by sand aquifers in West Tennessee and North Mississippi. Shelby County, Tennessee (Memphis, Tennessee) accounted for about 38 percent of the total public water supply regional pumping. The dominance of groundwater use over surface water in the western portion of the TVA region is due to the availability of prolific aquifers and the absence of adequate water resources in some areas.

This variation of groundwater use across the region is the result of several factors including: groundwater availability and quality, surface water availability and quality, determination of which water source can be developed most economically and public water demand, which is largely a function of population. There are numerous sparsely populated, rural counties in the region with no public water systems. Residents in these areas are self-served by individual wells or springs.

In 2010, estimated average daily water withdrawals in the TVA service area totaled 16,395 million gallons per day (MGD) (Bohac and Bowen 2012). About 5.2 percent of these water withdrawals was groundwater and the remainder was surface water. Since 1950, groundwater and surface water withdrawals by public supply systems in Tennessee have greatly increased. The magnitude and rate of growth of withdrawals of surface water has exceeded groundwater. The annual increase in groundwater withdrawals for public supply in Tennessee averaged about 2.5 percent. Although these data are for Tennessee public water supplies, they are representative of the overall growth in water use for the TVA region (TVA 2015b).

The quality of groundwater in the TVA region largely depends on the chemical composition of the aquifer in which the water occurs (Table 3-4). The chemical quality of most groundwater in the region is within health-based limits established by the EPA for drinking water. Pathogenic microorganisms are generally absent, except in areas underlain by shallow carbonate aquifers susceptible to contamination by direct recharge through open sinkholes (Zurawski 1978).

Groundwater use in the vicinity of TVA coal-fired power plants is variable and generally limited to private water supply wells.

3.6.1.4 Conceptual Site Model

The power plants at which ash impoundments are located were constructed adjacent to large streams and reservoirs that provided a source of cooling water for coal-fired power generating facilities. In general, groundwater in the vicinity of TVA's ash impoundments is both influenced by the surrounding upland, local geological conditions and the hydrologic influence of the receiving waterbody.

Depths to the uppermost aquifer will be investigated by TVA at all ash impoundments in accordance with the requirements of the CCR Rule.

The potential groundwater mounding under the unclosed impoundments as defined above may be expected to remain somewhat elevated even for an inactive impoundment (i.e., no additional CCR material inputs), due to the continued addition of storm water and other process wastewaters into the impoundment.

Because of this continued input of water to the impoundment, the quantity of water seeping vertically ("leachate" water) downward beneath the impoundment, subsurface flow may also be considered constant (EPRI 2015b). The extent to which such leaching may occur and how it may interact with the uppermost aquifer and receiving surface waters is dependent upon site-specific conditions such as: soil permeability, water depth within the impoundment, volume of CCR materials and their composition and depth to the uppermost aquifer, etc.

In general, it is expected that for the majority of TVA ash impoundments, the groundwater flow direction is likely reflective of topography and local geology and would be toward the receiving water body. Actual groundwater levels and directional flow are currently under investigation by TVA.

3.6.2 Environmental Consequences

3.6.2.1 Alternative A – No Action

Under Alternative A, impoundments will remain operational but will receive no new CCR except for those plants that would need to temporarily manage CCR during the transition to dry ash storage. No closure activities (e.g., decanting of surface water or cover system construction) will occur. The impoundments may, however, continue to receive process water and storm water runoff from the plant site. They eventually would not receive any additional CCR materials.

For the No Action Alternative, it is anticipated that due to the eventual cessation of sluicing activities, there would be some reduction of hydraulic inputs to the subsurface beneath the impoundments. It is anticipated that some reduction of any groundwater mounding would be correspondingly reduced. The reduction of a groundwater mound would conceivably lower the hydraulic head pressures driving a downward gradient of water and associated constituents. Accordingly, this alternative potentially would reduce any ongoing movement of constituents to groundwater or surface water.

3.6.2.2 Alternative B – Closure-in-Place

Under Alternative B, the decanting of surface water and subsequent grading and stabilization of the CCR materials in the impoundment provides an immediate reduction in the potential influx of leachate water moving from the impoundment through the subsurface vadose zone. The cover system with an approved closure system (see Section 2.2) over the compacted CCR not only prevents additional infiltration from precipitation, but also would facilitate management of storm water runoff. Elimination of the hydraulic inputs to the impoundment reduces the potential for migration of leachate to groundwater beneath the impoundment and to receiving surface waters.

Closure-in-place activities will reduce risk to groundwater and improve water quality in comparison to the No Action alternative. Even in cases where the elevation of the upper most aquifer is unknown, Alternative B provides the following benefits:

1. Elimination of process water reduces the hydraulic head, therefore reducing the pressure of water forcing ash contaminants into groundwater
2. Installing a cover system improves groundwater quality by virtually eliminating rainfall infiltration through the impoundment, and reducing downward migration of contaminants into groundwater.
3. NPDES outfall water quality improves as contact with ash would cease following installation of a cover system; and the receiving river water quality would also improve;
4. Natural groundwater quality would eventually be reestablished.

TVA's on-going monitoring of similar ash management facilities at its' plants also point to the effectiveness for those benefits mentioned above. In the case of CUF, when sluicing of CCRs changed from an open impoundment to sluicing in geomembrane-lined channels, groundwater parameters changed from exceeding the MCL to below the MCL. This has been stable for approximately 3 years. Closure-in-Place with a geomembrane is considered to be one of the best options for improving groundwater quality beneath or downgradient of an ash impoundment or landfill.

Groundwater analytical data from the most recent sampling events from similar facilities at sites evaluated in Part II of this EIS are available on TVA's project Web site (https://www.tva.gov/Environment/Environmental-Stewardship/Environmental-Reviews/Closure-of-Coal-Combustion-Residual-Impoundments).

No Federal post-closure care measures are required if an inactive ash impoundment is closed by April 17, 2018. If an ash impoundment is still active after the October 19, 2015, deadline, or if an inactive impoundment is not closed by the closure deadline, additional post-closure requirements will be required to maintain compliance with the CCR Rule. TVA will implement supplemental mitigative measures that include monitoring, assessment and corrective action programs as mandated by state requirements (see Section 2.2). Such measures will further minimize risk from closed impoundments.

Notably, a recent study conducted by EPRI has evaluated the impact of impoundment closure on groundwater constituents of concern (COC) for a hypothetical CCR impoundment in Tennessee. EPRI analyzed two scenarios: one in which all CCR materials were located above the water table and a second in which the groundwater intersected the CCR materials. Under both closure scenarios, EPRI found that the in-place closure scenario provided a positive impact compared to baseline (i.e., concentrations of all COCs were less than 10 percent of baseline), ranging from a 1.7 to 13.3-fold increase in positive impact (i.e., reduction in concentration) (EPRI 2015c).

Considering the beneficial effects of removal of the hydraulic head from ash impoundments, the associated reduction in potential subsurface discharges from ash impoundments and the commitment to supplemental mitigative measures such as groundwater monitoring, as appropriate, the impacts of this alternative on groundwater would be beneficial and considerable, as compared to the No Action Alternative.

3.6.2.3 Alternative C – Closure-By-Removal

Alternative C includes decanting of surface water, excavating and transporting of all CCR materials to an approved on-site or off-site disposal facility. As such, this alternative entails removing the potential source of COCs from the site.

As EPA identified in the CCR Rule, removal of the CCR materials will reduce groundwater risk in the impoundment area. The CCR being removed from an impoundment will be dried to an acceptable level prior to being loaded for off-site transport. The permitted landfills that receive CCR will be lined and have groundwater monitoring systems as required by their respective permits to minimize potential impacts to groundwater.

Groundwater benefits associated with this alternative include eliminating the potential interaction between the CCR and the uppermost aquifer. It will eliminate new groundwater risk from groundwater COCs migrating off-site.

In the analysis of the closure of the hypothetical CCR impoundment in Tennessee, EPRI also evaluated the potential effects of a closure scenario similar to Alternative C. EPRI found that this scenario has an incrementally more positive impact compared to baseline relative to the scenario similar to Alternative B (i.e., concentrations of all COCs are less than 100 percent of baseline), ranging from a 1.4 to 21.7-fold increase in positive impact for excavate and redispose (i.e., reduction in concentration) (EPRI 2015c). However, for facilities having larger volumes of CCR, the extended duration of removal (up to 70 years) would effectively diminish benefits to groundwater quality improvement relative to Alternative B.

No federal post-closure care measures are required if an ash impoundment is closed under Alternative C – Closure-by-Removal. State requirements for post-closure certification will be implemented as needed.

Depending on the volume of CCR to be removed, the impacts of this alternative on groundwater are beneficial and could be considerable, as it eliminates subsurface discharges and eliminates COCs from the former CCR impoundment when the removal project is completed. However, until the project is completed, which could take up to 70 years, the benefit to groundwater quality is expected to be less than the Closure-in-Place alternative because water infiltration through the CCR would essentially be stopped much earlier when the final cover system is in place.

3.7 Surface Water

3.7.1 Affected Environment

The affected environment that would possibly be impacted by TVA's impoundment closures, as regulated by the CCR Rule, would span several watersheds including the Tennessee River, the Cumberland River, the Ohio River, the Green River and the Mississippi River.

3.7.1.1 Affected Watersheds

3.7.1.1.1 Tennessee River

The Tennessee River watershed covers approximately 41,000 square miles (mi^2). This area includes 129 counties within much of Tennessee and parts of Alabama, Kentucky, Georgia, Mississippi, North Carolina and Virginia. The larger TVA power service area (PSA) covers 80,000 mi^2 and includes 201 counties in the same seven states.

The Tennessee River watershed begins with headwaters in the mountains of western Virginia and North Carolina, eastern Tennessee and northern Georgia. At Knoxville, Tennessee, the Holston and French Broad rivers join to form the Tennessee River, which then flows southwest through the state—gaining water from three other large tributaries: the Little Tennessee, Clinch and Hiwassee rivers. The Tennessee River eventually flows into Alabama, where it picks up another large tributary, the Elk River. At the northeast corner of Mississippi, the river turns north and re-crosses Tennessee—picking up the Duck River, and continues to Paducah, Kentucky where it enters the Ohio River.

The total river elevation change from the maximum reservoir surface elevation at Watauga Dam (highest elevation on the system) to the minimum tailwater surface elevation at Kentucky Dam (lowest elevation on the system) is 1,675 ft in 828.6 river miles. The Tennessee River, the main river, has a fall of 515 ft in 579.9 river miles from the top of the Fort Loudoun Dam gates to the minimum tailwater elevation at Kentucky Dam. The mainstem fall is gradual except in the Muscle Shoals area of Alabama, where a drop of 100 ft is found in a stretch of less than 20 mi (TVA 1990).

The Tennessee River basin contains all but one of TVA's dams and covers most of the TVA region. The entire length of the Tennessee River is regulated by a series of nine locks and dams built mostly in the 1930s and 1940s that allow navigation to Knoxville. Virtually all the major tributaries have at least one dam, creating 14 multi-purpose storage reservoirs and seven single-purpose power reservoirs. This system of dams and their operation is the most significant factor affecting water quality and aquatic habitats in the Tennessee River and its major tributaries.

Major water quality concerns within the Tennessee River drainage basin include point and non-point sources of pollution that degrade water quality at several locations on mainstream reservoirs and tributary rivers and reservoirs. Toxic substances have also been found in sediment and fish in reservoirs that otherwise have good water quality. Other water quality concerns include occurrences of low dissolved oxygen levels downstream of dams, which stresses aquatic life and limits the ability of the water to assimilate wastes.

The principal water quality concerns in TVA reservoirs and watersheds on which coal-fired generating stations are located are summarized in Table 3-5. This summary reflects the current understanding of the causes and effects of point and non-point sources of pollution on water quality (TVA 2015).

Point and non-point sources of pollution within TVA reservoirs and watersheds include:

- Heat-releases – Utility and industrial plants may release water into streams or lakes that has been heated above the ambient temperature of the body of water.
- Wastewater discharges – Sewage treatment systems, utilities, industry and others dispose of waste into streams and lakes.
- Runoff from agriculture, urban uses and mined land.
- Air pollution – Pollutant concentrations in the air can affect surface waters through rain and deposition.

Several of the waters discussed above and in Table 3-5 are listed as impaired in 303(d) lists published by their respective state's environmental agencies. However, those 303(d) listings are primarily for pollutants such as mercury from atmospheric deposition or toxic organics in contaminated sediments, not for constituents normally found in CCRs.

3.7.1.1.2 Cumberland River

The Cumberland River and its tributaries generally exhibit moderate to high concentrations of calcium and magnesium and a slightly alkaline pH because much of the basin is comprised of limestone and dolomitic bedrock. Low concentrations of dissolved solids in the upper Cumberland contrast with the generally higher concentrations of dissolved solids in the lower Cumberland watershed, due in part to a change in geology in the Nashville area. The area east of Nashville is underlain by Ordovician Age limestones and shales, which is more resistant and less soluble than the Mississippian Age limestones, found in the area west of Nashville. The first is more resistant and less soluble than the latter.

Generally, the mainstream Cumberland River exhibits lower suspended solids concentrations than its tributaries. The higher values in the lower Cumberland watershed tributaries are caused in part by differences in topography, land use, soil type and geology.

In general, water quality of the mainstem Cumberland River in the vicinity of GAF and CUF is good.

3.7.1.1.3 Ohio River

The lower Ohio River receives drainage from an extensive 204,000 mi^2 watershed that reaches into 13 states, encompassing much of the east central United States. The upper Ohio Valley is highly industrialized, and the sources of pollution from industrial and municipal sources are many and varied. Non-point source pollution, primarily from agricultural runoff and mining, also contributes to the sediment and pollution load. A series of locks and dams allows commercial navigation along the entire 981-mi length of the river from the Mississippi River to Pittsburgh, Pennsylvania. About 136 million metric tons of freight are transported on the Ohio annually. TVA's SHF is located on the Ohio River at approximately Ohio River Mile 946 just downstream from Paducah, Kentucky.

Table 3-5. Principal Water Quality Concerns in TVA Reservoirs

Plant Name	TVA Reservoirs with Coal-Fired Plants	Uses Affected				Source	
		Aquatic Life	Fish Consumption	Recreation	Water Supply	Point	Non-Point
ALF	McKeller Lake/Mississippi River	Low Dissolved Oxygen	Chlordane	E. Coli		X	X
BRF	Clinch River, Melton Hill Reservoir		Polychlorinated Biphenyl (PCB)				X
COF	Tennessee River, Pickwick Reservoir				Algae		X
CUF	Cumberland River, Barkley Reservoir	Thermal	Mercury			X	X
GAF	Cumberland River, Old Hickory Reservoir			E. Coli		X	X
JOF	Tennessee River, Kentucky Reservoir			Aquatic Plants		X	
JSF	Holston River, Ft. Loudoun Reservoir		PCBs	Bacteria		X	X
KIF	Emory River, Watts Bar Reservoir	Low Dissolved Oxygen	PCBs			X	X
PAF	Green River		Mercury	Fecal Coliform		X	X
SHF	Ohio River		PCBs, Mercury and dioxin	E Coli		X	X
WCF	Tennessee River, Guntersville Reservoir			Aquatic Plants			X

The Ohio River supplies more than one-half of all surface water withdrawn in the state of Kentucky. It forms the northern boundary of Kentucky for a distance of 664 stream mi. The river system drains an area of 33,300 mi^2 in Kentucky (about 82 percent of the state). Identifying sources of contamination in such a large basin is difficult. The Ohio River Valley Water Sanitation Commission is responsible for evaluating water quality in the main stream.

Fish consumption advisories have been placed on paddlefish, paddlefish eggs (harvested for caviar), channel catfish, carp and white bass along the entire length of the Ohio River bordering Kentucky because of chlordane (a pesticide) and PCB contamination. Little Raven Creek, a tributary below Paducah, has a consumption advisory for all fish species due to PCB contamination. Also, the West Kentucky Wildlife Management Area Lakes, which are oxbow and overflow lakes that drain into the Ohio River below Paducah, have a consumption advisory for largemouth bass because of mercury contamination.

3.7.1.1.4 Green River

The Green River Basin is located in south central Kentucky and north central Tennessee. The drainage area is 9,273 mi^2, of which 377 mi^2 are in Tennessee. The Green River rises in Lincoln and Casey counties in Kentucky and flows generally westward for 330 mi to its confluence with the Ohio River just upstream from Henderson, Kentucky. A system of seven locks and dams enables navigation on the downstream portion of the Green River.

The upper basin is characterized by rugged, hilly terrain. The central part of the basin drains the Karst region, an area that is interlaced with large cave systems. The Karst region includes Mammoth Cave National Park. In the Karst region, surface streams are almost non-existent. Most of the water drainage is subterranean, eventually draining to the Green River via large springs. The lower basin consists primarily of alluvial plains. TVA's PAF is located on the Green River about 100 mi from the mouth.

The Green River basin contains about one-fourth of Kentucky's land area and is the largest drainage basin in the state. Reservoirs have been constructed by the USACE on the Rough, Nolin and Barren rivers, as well as on the mainstream of the Green River in the upper basin. The topography in this section of the Interior Low Plateaus is characterized by gently rolling terrain underlain by limestone in the upper basin and hills and broad flood plains underlain by sandstone, shale and coal in the lower basin.

Land uses in the upper basin include agriculture, urban areas and mining or drilling. Major sources of stream contamination in the upper basin are agriculture (sediment, nutrients and pesticides); mining or drilling (chloride); on-site and municipal wastewater treatment systems (decomposable organic matter, nutrients and bacteria); and urban storm water runoff (toxic metals, nutrients and sediment).

Concentrations of chloride in the upper basin of the Green River are higher than those recorded at other locations in the basin and have been associated with brines from oil production. However, dissolved solids concentrations in the upper basin were not high relative to those in other Kentucky streams. Concentrations of sulfate, another major component of dissolved solids were low in samples collected during 1987-1989. The relatively high median concentrations of nitrite [0.87 milligrams per liter (mg/l)] and suspended sediment (27 mg/l) were among the highest for Kentucky's monitoring locations. The high values possibly were due to agricultural and urban runoff and municipal wastewater discharges.

The major source of pollution in the Green River Basin is mining in the western coal-fields region of the lower basin. The river is very turbid or cloudy due to runoff from these coal fields and extensive barge traffic. Other sources of pollution in the basin include municipal wastewater-treatment plants and agricultural runoff. Two streams in the basin currently have fish consumption advisories in place for PCB contamination: Drakes Creek from the city of Franklin to the Barren River and Mud River from the city of Russellville to the Green River.

PAF is located at approximately Green River mile (GRM) 100. Overall, water quality is good in the Green River Basin. However, according to the 2012 303(d) List of Waters for Kentucky, approximately 330 stream miles have been identified on the 303(d) list of impaired streams for pH, dissolved solids and excessive fecal coliform (KDEP 2013). Three segments of the Green River are listed on the state 303 (d) report as "fair," meaning they only partially support their designated uses. Two of these sites are upstream of the project site and one, a 22.5 mi section of the Green River downstream (GRM 71.9 to 94.4), is downstream of the plant. The downstream listing is due to fecal coliform from an unknown source. The listed pollutants of concern include fecal coliform and mercury in fish tissue. The listed probable sources of pollutants are resource extraction, land disposal and agriculture (KDEP 2013). Additionally, the Green River at GRM 189-290, approximately 90 mi upstream, is on the Nationwide Rivers Inventory. However, no Nationwide Rivers Inventory streams or Wild and Scenic Rivers are near the proposed action. Jacobs Creek and the portion of the Green River adjacent to PAF are currently not assessed. The Green River at PAF is not listed as impaired in Kentucky's 2012 303(d) list. A section downstream from GRM 94.4 to GRM 71.9 is listed for fecal coliform from an unknown source. This could not be caused by CCRs.

3.7.1.1.5 Mississippi River

The lower Mississippi River in the reach that borders west Tennessee is one of the largest rivers in the world. Its drainage basin includes nearly all of the United States between the Rocky Mountains and the Appalachian Mountains. The drainage basin is 1,247,000 mi^2 and includes the nation's most productive industrial and agricultural regions. Ships can travel the river for more than 1,800 mi from Minneapolis, Minnesota to the Gulf of Mexico. TVA operates the ALF on McKellar Lake which drains to the Mississippi River at Memphis, Tennessee.

The Mississippi River has an average daily discharge of 312,000 MGD at Memphis, Tennessee and 377,000 MGD at Vicksburg, Mississippi. In general, the quality of water in the Mississippi River is suitable for most uses. The median concentrations of alkalinity (106 mg/l), sulfate (55 mg/l), dissolved solids (239 mg/l) and nitrite plus nitrate (1.2 mg/l) were much less than the federal criteria for untreated drinking water supplies. About half of the sulfate in the Mississippi River is due to runoff over weathered rock and the other half is due to biochemical processes and human activities.

A fish consumption advisory for chlordane contamination is in effect for all fish species in the Mississippi River adjacent to Shelby County, Tennessee (Memphis) and McKellar Lake, Wolf River, Loosahatchie River and Nonconnah Creek, which are tributaries to the Mississippi River in Shelby County.

3.7.1.2 Characteristics of Ash Impoundment Discharges

TVA CCR impoundments include stilling basins, sluice channels, fly ash or bottom ash or gypsum impoundments and dredge cells that vary in size and CCR material composition. Typical operational characteristics of coal-fired power plants have included a wet sluicing operation whereby CCR materials are removed from the plant to CCR settling basins. Most of these settling basins contain surface water that is part of the overall treatment system designed to capture and collect CCR materials and improve water quality prior to discharge to receiving waters.

Water use to support hydraulic sluicing of CCR materials is typically facilitated by with-drawing water from the adjacent surface water body or reusing water that has been used for condenser cooling operations. Pumping rates to support CCR management within TVA coal-fired power plants range with the size of the plant and volume of material generated. Some impoundments are inactive. Some sites have been converted to dry handling of fly ash and some have been converted to dewatered CCR systems. Dry handling will have no CCR sluice water flow, however, dewatered CCRs may still have water flows after the CCR material has been separated. As summarized in Table 3-6, sluice water flow ranges from a low of 0.6 MGD at BRF to approximately 28 MGD at PAF. Additional storm water inputs and process water from the plant combine to contribute to an average total discharge flow from CCR impoundments that range from 8.5 MGD at COF to 33 MGD at PAF which demonstrates that the average CCR sluice flow accounts for between 60 percent and 90 percent of the total CCR impoundment discharge.

Table 3-6. CCR Impoundment Flow Estimates

Plant	CCR Type (by flow stream)	NPDES # and Outfall Number	Average Total Flow (MGD)	Average Ash Sluice Flow (MGD)
ALF	Fly ash and boiler slag	TN0005355, 002*	NA	NA
	Fly ash and boiler slag	TN0005355, 001	8.6	7.3
BRF	Bottom ash (sluice water recycled except for overflow to gypsum system)	TN0005410, 001		
	Gypsum	TN0005410, 001	11.0	0.6
	Fly ash (handled dry)	TN0005410	NA	NA
COF	Bottom ash and fly ash	AL0003867, 001	8.5	5.4
CUF	Bottom ash and gypsum	TN0005789, 001	21.7	12.8
GAF	Bottom ash and fly ash	TN0005428, 001	27.9	21.6
JSF	Bottom ash and fly ash	TN0005436		
JOF	Bottom ash and fly ash	TN0005444, 001	31.1	24.9
KIF	Bottom ash and fly ash	TN0005452, 001	15.6	0
	Bottom ash	TN0005452, 001	15.3	6.8
PAF	Fly ash and Bottom Ash	KY0004201, 001	33.4	27.8
	Bottom Ash	KY0004201, 002	28.3	28.3
SHF	Bottom ash and fly ash	KY0004219, 001	25.8	19.8
WCF	Bottom ash, fly ash and gypsum	AL0003875, 0001	31.4	20.4

*ALF Outfall 002 is inactive and has no surface discharge

Most CCR impoundments have NPDES permits that have monthly average and daily maximum limitations on the discharge of total suspended solids (TSS). Monthly average TSS NPDES permit limitations range from 15 to 30 mg/l and daily maximum limitations range from 70 to 100 mg/l.

The primary withdrawal usage for TVA's coal-fired power plants is for the condenser cooling water (CCW), which accounts for the majority of the thermal loading from operating plants. The discharge characteristics associated with CCW use (including thermal loading) would not be changed by CCR management activities. Raw and potable waters and storm water flows associated with ash impoundments would only be subject to temperature increases from natural cycles in solar radiation.

Additionally both passive and targeted wastewater treatment would be introduced as appropriate to comply with NPDES permit limits, and potentially applicable requirements under EPA's new Effluent Limitation Guideline (ELG) for coal-fired power plants [80 Fed. Reg. 67838-67903 (Nov. 3 2015)]. TVA is reviewing the final ELG to determine what actions may be required to comply with it.

3.7.2 Environmental Consequences

3.7.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, TVA will not close any of the CCR impoundments. This alternative does not meet the purpose of complying with the CCR Rule or of achieving the overall TVA goal of closing CCR impoundments as part of its process to convert wet CCR storage to dry storage.

Under this alternative, the discharges from CCR impoundments would continue at plants for which the CCR impoundment is a component of the storm water or process water treatment system. However, the volume and rate of discharge would be reduced relative to the operating condition in which CCR would have been sluiced to the impoundment. Additionally, the hydraulic head would remain within the impoundment but likely would be reduced. Discharges will continue to comply with applicable permit limits and therefore, surface water quality adjacent to these facilities should remain approximately the same. Operational changes such as additional treatment, would be implemented as necessary to meet applicable permit limits, including new effluent guidelines.

Potential indirect impacts from the No Action Alternative include the potential for seepage from berms and groundwater and possible release to surface waters. Under this alternative, any pathways for transport of COCs as a result of lateral movement (seepage) through berms or groundwater flow to adjacent surface waters would continue but at a reduced level.

3.7.2.2 Alternative B – Closure-in-Place

3.7.2.2.1 Surface Water Withdrawal and Discharge

The primary withdrawal of surface water plant-wide is for the CCW, which carries the majority (99.9 percent) of the thermal loading from the fossil sites. Raw and potable waters and storm water flows associated with CCR management activities would remain at ambient temperatures; therefore, no additional thermal impacts would be anticipated.

Impoundment closure under this alternative will typically result in isolation and rerouting of discharge water streams (storm water, plant sump and process water, etc.) to discontinue their discharge to the CCR impoundment. To the extent possible, the majority of the storm water flows will be managed through the implementation of BMPs and cleaning and maintenance plans and discharged to the receiving stream in accordance with NPDES permit limits.

The decanting of the water currently in the impoundment will begin once the process and storm water streams have been re-routed from the impoundment. After the flows are diverted, the impoundment will be decanted by various means, including but not limited to natural dissipation; pumping into another impoundment and then discharging, and/or pumping directly to the permitted outfall to the receiving stream if allowed under the applicable permit or regulations. Rainfall and water levels will be monitored to determine the appropriate decanting rate. Discharge flow rates will be maintained to ensure compliance with NPDES permit limits and protection of water quality in the receiving stream. This may require additional treatment. Additional monitoring of discharge constituents would be undertaken, as appropriate.

3.7.2.2.2 Construction Impacts

Under this alternative no alteration or modification of surface water resources would occur within the immediate project site or associated laydown areas with the implementation of BMPs.

Wastewaters generated during the proposed project may include construction storm water runoff, drainage of work areas, domestic sewage, non-detergent equipment washings, dust control and hydrostatic test discharges.

- **Surface Runoff –** Impoundment closure activities have the potential to temporarily affect surface water via storm water runoff. TVA will comply with all appropriate state and federal permit requirements. Appropriate BMPs will be followed and all proposed closure activities will be conducted in a manner to ensure that waste materials are contained. A Construction Storm Water Permit will be in effect that will require development of a project-specific Storm Water Pollution Prevention Plan. This plan will identify specific BMPs to address construction-related activities that will be adopted to minimize storm water impacts. Additionally, BMPs, as described in A Guide for Environmental Protection and Best Management Practices for Tennessee Valley Authority (Bowen et al. 2012), will be used to avoid contamination of surface water in the project area. Therefore, no significant impacts to surface water would be expected due to surface water runoff from the construction site.
- **Domestic Sewage –** Portable toilets will be provided for the additional construction workforce as needed. These facilities will be managed and maintained appropriately to avoid any releases during the construction operation.
- **Equipment Washing and Dust Control –** Equipment washing and dust control discharges will be handled in accordance with BMPs described in the Storm Water Pollution Prevention Plan for water only cleaning and/or by the facility’s individual NPDES Permit.
- **Hydrostatic Testing –** These discharges will be handled in accordance with the NPDES Permit, or in Tennessee, the TDEC General NPDES Permit for Discharges of Hydrostatic Test Water (TN670000).

With the implementation of appropriate BMPs, no significant impacts to surrounding surface waters are expected from construction activities.

3.7.2.2.3 Operational Impacts

In comparison to the No Action Alternative, Alternative B (Closure-in-Place) would greatly reduce discharges from existing CCR impoundments. Any hydraulic conductivity from groundwater to surface waters adjacent to the impoundments should be essentially eliminated by reduction of the hydraulic head in the impoundments and by consolidation and compaction of CCR. Installation of approved closure systems (see Section 2.2) would also greatly reduce any precipitation percolation through the CCRs, such that infiltration would be *de minimis*.

Notably, a recent study conducted by EPRI has evaluated the impact of impoundment closure on surface water for a hypothetical CCR impoundment in Tennessee. Under a closure scenario similar to Alternative B, EPRI analyzed the potential for COC releases from groundwater and the resultant effect on receiving surface waters. EPRI analyzed two scenarios: one in which all CCR materials were located above the water table, and a second in which the groundwater intersected the CCR materials. Under both closure scenarios, EPRI found that the in-place closure scenario provided a positive impact compared to baseline (i.e., concentrations of all COCs, with the exception of Arsenic(V), are less than 100 percent of baseline), ranging from a 2.5 to 7-fold increase in positive impact. Arsenic (V) migrates very slowly, thus, surface water concentrations are the same for all scenarios including baseline (EPRI 2015c).

Impoundment closure will in most cases, also entail removal of existing CCR impoundment outfall structures. Storm water collected from within the closed impoundment and other site storm water will be managed and rerouted as appropriate in accordance with NPDES permitting requirements. As a result, CCR impoundment closure would reduce current surface water loadings through NPDES discharge points by hundreds to thousands of pounds of TSS each day at each plant. Constituents such as oil and grease and metals in other waste streams will be diverted and managed separately in accordance with appropriate regulations. Additionally all other plant water sources previously contributing to CCR impoundment discharge will be rerouted to appropriate approved permitted outfalls.

This alternative would eliminate any substantial lateral movement (seepage) through berms or groundwater flow and their potential subsequent release to surface waters. Consequently, any pathways for transport of COCs by these mechanisms would be minimized.

Because surface water flow and potential lateral movement (seepage) through berms or groundwater flow to surface waters would be greatly reduced, and because all work will be done in compliance with applicable regulations, permits, and BMPs, potential direct and indirect adverse impacts to surface waters would be negligible and effect on surface water quality should be beneficial.

3.7.2.3 Alternative C – Closure-by-Removal

No alteration or modification of surface water resources would occur within the immediate project site or associated laydown areas with utilization of proper BMPs during construction. Water withdrawal and discharge impacts would be essentially the same as those described for Alternative B and will include re-routing of project flows and the drawdown of the free water in the impoundments.

In contrast to Alternative B, this alternative will entail the removal and transport of all CCR material from the project site to an approved landfill. As a result, any pathways for transport of COCs as a result of berm underseepage or groundwater discharge to adjacent surface waters would be eliminated over time. Material placed within the receiving landfill is assumed to be fully contained by an approved liner system such that no seepage or discharge of COCs to receiving waters would occur.

The construction activities associated with the closure of impoundments impacts would be similar to those described above in Alternative B. The duration of the construction process has the potential to be much longer than Alternative B, however. On-site construction impacts are expected to be relatively minor as long as all BMPs and other appropriate mitigation measures are implemented.

EPRI found that the excavate and redispose closure scenario (Closure by Removal) provided a positive impact compared to baseline *(*i.e., concentrations of all COCs, with the exception of Arsenic(V), are less than 100 percent of baseline), ranging from a 2.5 to 9.5-fold increase in positive impact. Arsenic (V) migrates very slowly, thus, surface water concentrations are the same for all scenarios including baseline (EPRI 2015c).

The impacts due to operational activities associated with the closure of impoundments would be similar to those described above in Alternative B. As long as mitigation measures are utilized as needed, such as water treatment, proper drainage and BMPs, no negative surface water quality impacts are anticipated.

Because surface water flow and potential underseepage and groundwater releases to surface waters eventually would be eliminated, and because all work will be done in compliance with applicable regulations, permits, and BMPs, potential direct and indirect impacts to surface waters would be negligible. Compared to Alternative B, however, any ongoing surface water impacts would be reduced more slowly because precipitation events would continue to influence flows from the CCR facility until the end of the closure process.

3.8 Floodplains

3.8.1 Affected Environment

A floodplain is the relatively level land area along a stream or river that is subjected to periodic flooding. The area subject to a 1 percent chance of flooding in any given year is normally called the 100-year floodplain. The area subject to a 0.2 percent chance of flooding in any given year is normally called the 500-year floodplain.

The affected environment includes the ash ponds and the streams adjacent to them. The ash impoundments associated with coal-fired power plants in the TVA fleet and the adjacent streams are presented in Table 3-7.

The ash impoundments are currently open to the atmosphere. With the exception of the ALF West Impoundment, the low crest elevations of the ponds specifically analyzed in this review are not only above the 100-year flood elevation, but also above the 500-year flood elevation. The low crest of the ALF West Impoundment is located above the 100-year flood elevation and below the extrapolated 500-year flood elevation of 230.5 ft.

Table 3-7. CCR Impoundments at TVA Coal-Fired Plants

Ash Pond	Stream Name	River Mile*	100-year Flood Elevation	500-year Flood Elevation	Existing Impoundment Crest Elevation (ft)
ALF West Impoundment	Lake McKellar	2.0	225	230.5	226.9
BRF Sluice Channel	Clinch River	47.9	797.3	798.1	809.6
BRF Fly Ash Impoundment	Clinch River	46.7	797.2	797.9	809.1
COF Ash Impoundment 4	Cane Creek (influenced by Tennessee River backwater)	3.2-3.8	423.2	424.4	457.6
COF Laydown Area 9 acres	Cane Creek (influenced by Tennessee River backwater)	3.1	423.1	424.3	~430 (from topographic map)
CUF	Cumberland River	102.8	379.6	385.3	To be determined in site-specific analysis
GAF[a]	Cumberland River	244.4	453.3	457.0	To be determined in site-specific analysis
JSF Bottom Ash Impoundment	Holston River	106.1	1078.0	1082.3	1143.9
JOF[a]	Tennessee River	99.5	375.0	375.0	To be determined in site-specific analysis
KIF Stilling Impoundment	Emory River	2.1	748.1	750.7	764.5
KIF Laydown Area	Emory River	1.8	747.8	750.2	~760 (from topographic map)
KIF Sluice Trench	Emory River	1.8	747.8	750.2	~760 (from topographic map)
PAF[a]	Green River	100.4	402.1	404.9	To be determined in site-specific analysis
WCF Dredge Cell	Widows Creek (influenced by Tennessee River backwater)	2.2	608.1	610.7	636.9
WCF Ash Impoundment	Widows Creek (influenced by Tennessee River backwater)	3.2	608.1	610.7	635.4

* General river mile of coal-fired plants.

3.8.2 Environmental Consequences

As a federal agency, TVA is subject to the requirements of EO 11988, Floodplain Management. The objective of EO 11988 is "…to avoid to the extent possible the long- and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative" (U.S. Water Resources Council 1978). The EO is not intended to prohibit floodplain development in all cases, but rather to create a consistent government policy against such development under most circumstances. The EO requires that agencies avoid the 100-year floodplain unless there is no practicable alternative. For certain "Critical Actions," the minimum floodplain of concern is the 500-year floodplain.

3.8.2.1 Alternative A – No Action

The No Action Alternative will result in the same impacts to floodplains and floodplain resources as existing conditions. Existing berms will be maintained as part of on-going care and maintenance of the TVA facility. Flood events greater than a 500-year flood could potentially occur at TVA coal-fired plants that could inundate the ash impoundments. Impoundment material could potentially be washed out of the ponds and into the receiving stream. The downstream extent of ash deposition in the receiving stream would be dependent upon the nature of both the flood event and the amount of ash released. Based upon hydraulic modeling done following the release of ash at the Kingston coal-fired plant in 2008, ash deposition in the receiving streams could fill the river bottom such that upstream flood elevations could be increased (TVA 2009). However, TVA has not experienced such flooding during the lives of these CCR impoundments.

3.8.2.2 Alternative B – Closure-in-Place

Under the Closure-in-Place alternative, flood events greater than the 500-year flood could occur that could inundate the ash impoundments; however, the ash will be covered by a final cover system designed to minimize erosion and infiltration to the ash within. With such a closure system in place, CCRs could still potentially be washed out of the ponds and into the receiving stream. However, the downstream extent of ash deposition in the receiving stream would be expected to be less than existing conditions. The impacts of berm erosion under the Closure-in-Place alternative would be less than existing conditions.

Structures and facilities such as laydown areas, haul roads, and staging areas will be constructed, and portions of them could be located within 100-year floodplains. These activities would be considered temporary uses of the 100-year floodplain and, therefore, would have no permanent impacts on floodplains or floodplain resources. Also, standard BMPs will be employed in order to minimize adverse impacts during construction activities.

3.8.2.3 Alternative C – Closure-by-Removal

Under Alternative C – Closure-by-Removal, flood events greater than the 500-year flood could occur that could inundate the closed ash ponds; however, the ash will have already been removed and, therefore, no ash would wash out into the receiving stream. In addition, closure of the former ash impoundment site incrementally increases the overall flood storage potentially. The impacts of berm erosion under the Closure-by-Removal alternative would be less than both existing conditions and the Closure-in-Place alternative. Under Closure-by-Removal, ash will be hauled to an approved landfill for final disposal. Because removal of CCR could take years at some locations, floodplain impact risks would remain but would be gradually reduced. TVA will ensure that Closure-by-Removal would not promote unwise use of the floodplain by obtaining documentation from a permitted landfill that the ash would be disposed in an area outside the 100-year floodplain.

Structures and facilities such as laydown areas, haul roads and staging areas will be constructed and portions of them could be located within 100-year floodplains. These activities would be considered temporary uses of the 100-year floodplain and, therefore, would have no permanent impacts on floodplains or floodplain resources. Also, standard best management practices will be employed in order to minimize adverse impacts during construction activities.

3.9 Vegetation

3.9.1 Affected Environment

The TVA region encompasses eight ecoregions (Figure 3-4) which generally correspond with physiographic provinces and sections described in Section 3.5. The terrain and associated plant communities vary from bottomland hardwood and cypress swamps in the floodplains of the Mississippi Alluvial Plain to high elevation balds, spruce-fir and northern hardwood forests in the Blue Ridge. About 3,500 species of herbs, shrubs and trees occur in the TVA region (TVA 2015b). The eight ecoregions in the TVA project area include:

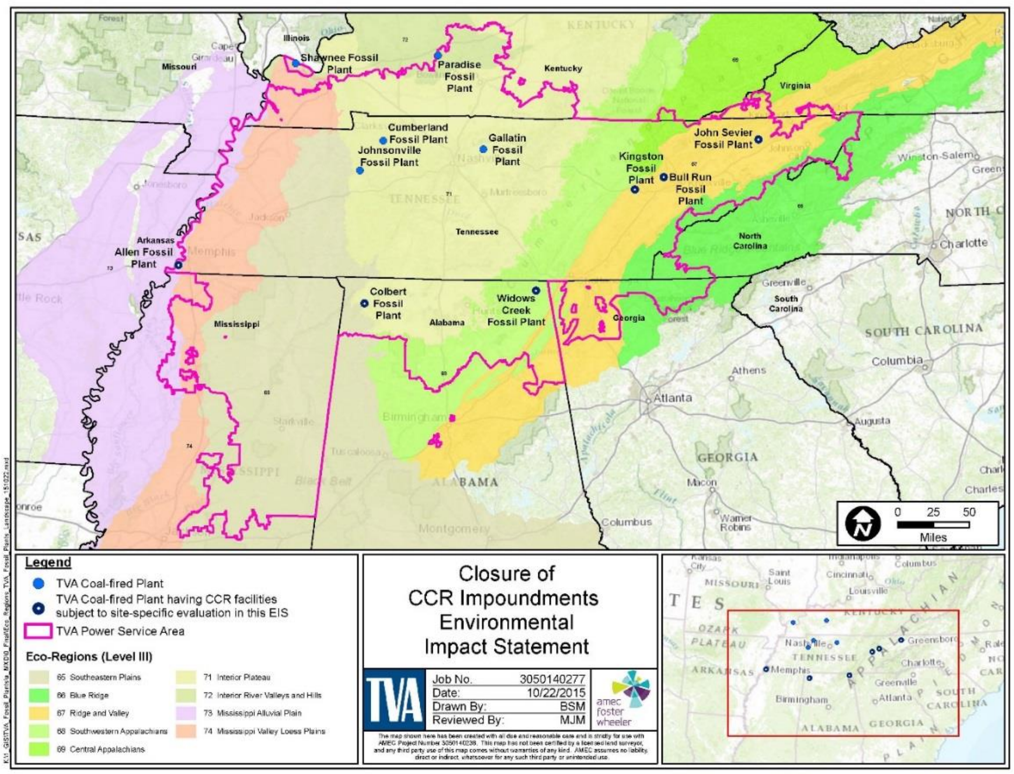

Figure 3-4. Ecoregions within the TVA Valley

- **Southern Blue Ridge Ecoregion**: This ecoregion corresponds to the Blue Ridge physiographic province. It is dominated (80 percent) by the diverse, hardwood-rich mesophytic forest and its Appalachian oak subtype, about 14 percent of the land cover is agricultural and most of the remaining area is developed (6 percent).
- **Ridge and Valley Ecoregion**: This ecoregion corresponds with the Valley and Ridge physiographic province, 56 percent of which is comprised of hardwood-rich mesophytic forest and its Appalachian oak subtype. About 30 percent of the area is agricultural and 9 percent is developed.

- **Central Appalachian Ecoregion**: This ecoregion corresponds with the Cumberland Mountains physiographic section. It is heavily forested (83 percent), primarily with mesophytic forests including large areas of Appalachian oak (Dyer 2006, USGS 2014). The remaining land cover is mostly agriculture (7 percent), developed areas (3 percent) and mined areas (3 percent).
- **Southwestern Appalachian Ecoregion**: This ecoregion corresponds with the Cumberland Plateau physiographic section. About 75 percent of the land cover is forest, predominantly mesophytic forest; about 16 percent is agricultural and 3 percent is developed.
- **Interior Plateau Ecoregion**: This ecoregion corresponds with the Highland Rim and Nashville Basin physiographic sections. About 38 percent of the ecoregion is forested, 50 percent is agriculture and 9 percent developed. Forests are predominantly mesophytic, with a higher proportion of American beech, American basswood and sugar maple than in the Appalachian oak subtype.
- **Interior River Valley and Hills Ecoregion**: This ecoregion is relatively flat lowland dominated by agriculture (68 percent) with about 20 percent forested hills, 7 percent developed and 5 percent wetlands.
- **Southeastern Plains and Mississippi Valley Loess Plain Ecoregion**: These two ecoregions correspond, respectively, to eastern and western portions of the East Gulf Coastal Plain physiographic section. These ecoregions are characterized by a mosaic of forests (52 percent of the land area), agriculture (22 percent), wetlands (10 percent) and developed areas (10 percent). Forest cover decreases and agricultural land increases from east to west.
- **Mississippi Alluvial Plain Ecoregion**: This ecoregion is a flat floodplain area originally covered by bottomland deciduous forests. A large portion has been cleared for agriculture and subjected to drainage activities including stream channelization and extensive levee construction. Most of the land cover is agricultural (approximately 80 percent) and the remaining forests are southern floodplain forests dominated by oak, tupelo and bald cypress.

In most cases, TVA coal-fired power plants were developed in close association with large rivers and reservoirs that provide sufficient water supply for condenser cooling. As such, coal-fired plants and their supporting facilities including ash impoundments are predominantly located within floodplain landscapes of major river and reservoir systems of the Valley. Dominant plant communities that are common to floodplains within the Valley across ecoregions include bottomland deciduous forest that support green ash, elm, sugarberry, eastern sycamore and sweetgum; emergent and shrub wetland communities composed of cattail, rushes, buttonbush and willows and agricultural uses (hayland, pasture, cultivated field).

Impoundment closure activities considered by TVA are typically limited in their scope at each coal-fired generation station. Activities would be primarily focused within the limits of the ash impoundments subject to closure, associated previously disturbed areas on the project site and roadways serving the facility. As such, plant communities present in the various ash impoundments and related construction laydown areas potentially affected by project operations consist of ruderal/early successional vegetation (often within older, exposed ash in upper portion of impoundments), maintained lawn/turf associated with berms, denuded and unvegetated lands (parking lots, riprapped berms, etc.) and fringing scrub and sapling trees. Dominant land cover types include open water, hay/pasture, cultivated crops, deciduous forest and developed land.

3.9.2 Environmental Consequences

3.9.2.1 Alternative A – No Action

Under the No Action Alternative, TVA will not close ash impoundments at any of the coal-fired plants. Under this alternative, there would be no impacts to vegetation.

3.9.2.2 Alternative B – Closure-in-Place

Ash impoundments are located in landscapes dominated by heavy industrial uses. Impacts to vegetation would result from earthmoving activities related to shaping and filling the ash within the impoundments, inward reconfiguration of berms and grubbing of laydown areas. Because plant communities within the impoundments and most laydown areas of TVA coal-fired sites are often disturbed and of low quality, and potential impacts are very small relative to the abundance of similar cover types within the vicinity, direct impacts from site construction activities would be negligible. Tree removal requirements are expected to be negligible at most facilities.

Sub-alternatives B-1 and B-2 include revegetation as part of the cover system (see Section 2-2). Placement of fill material will also result in a shift in cover from its current condition (typically denuded, exposed ash or herbaceous adventives), to a turf grass community. In contrast, Sub-Alternative B-3 utilizes an engineered turf cover system that would eliminate all vegetation as part of the cover system.

Construction activities associated with the Closure-in-Place Alternative may also result in the introduction and/or spread of invasive plant species from borrow material and heavy equipment. Invasive plants that pose a threat in the TVA region include tree-of-heaven, English ivy, autumn olive, Japanese honeysuckle, Chinese lespedeza and Johnson grass. However, the generalized transformation of existing ash impoundments from highly disturbed environments to stable, controlled and vegetated landscapes provide a net improvement in the overall composition of the plant communities of these sites and their ability to resist establishment by invasive species. Additionally, BMPs consisting of erosion control measures and use of approved, non-invasive seed mixes designed to quickly establish desirable vegetation will further minimize invasive plant impacts.

Impacts to vegetation under this alternative are limited to construction-phase disturbance of largely industrialized environmental settings that lack notable plant communities. Impacts to these plant communities are considered to be small relative to the abundance of similar cover types within the vicinity of each facility. Additionally, the transition of these predominantly denuded ash impoundments to vegetated, stable facilities demonstrates minor long term beneficial impacts on plant communities.

3.9.2.3 Alternative C – Closure-by-Removal

Impacts to vegetation under this alternative will be associated with ash removal and transport to either approved on-site or off-site permitted landfills. As with Alternative B, any existing vegetation would be entirely removed from the impoundments and from associated laydown areas needed to support construction. Ash impoundment re-use would be determined on a site-specific basis, but much of the former ash impoundment may be expected to revert to naturalized landscapes.

Construction activities associated with the Closure-by-Removal Alternative may also result in the introduction and/or spread of invasive plant species by heavy equipment use, off-site transport of CCR materials and abandonment of the former ash impoundment. However BMPs consisting of erosion control measures and use of approved, non-invasive seed mixes designed to quickly establish desirable vegetation will minimize invasive plant impacts.

Impacts to vegetation under this alternative are limited to construction-phase disturbance of largely industrialized environmental settings that lack notable plant communities. Additionally, the transition of these predominantly denuded ash impoundments to vegetated, naturalized environments demonstrates that impacts on plant communities are considered minor and beneficial in the long term.

3.10 Wildlife

3.10.1 Affected Environment

The TVA region encompasses nine community ecoregions (Omernik 1987). The terrain, plant communities, and associated wildlife habitats in these ecoregions vary from bottomland hardwood and cypress swamps in the floodplains of the Mississippi Alluvial Plain to high elevation balds and spruce-fir and northern hardwood forests in the Blue Ridge. About 3,500 species of herbs, shrubs and trees, 55 species of reptiles, 72 species of amphibians, 182 species of breeding birds and 76 species of mammals occur in the TVA region (Ricketts et al. 1999, Stein 2002, Tennessee Wildlife Resources Agency 2005, Tennessee Ornithological Society 2014). Although many plants and animals are widespread across the region, others are restricted to one or a few ecoregions. For example, high elevation communities in the Blue Ridge support several plants and animals found nowhere else in the world (Ricketts et al. 1999), as well as isolated populations of species typically found in more northern latitudes.

Many wide-ranging species occur throughout the TVA region; most species that are tolerant to humans continue to thrive in the region. Wildlife populations have been greatly altered by loss and modification of habitats due to agriculture, mining practices, forestry practices, urbanization, and the construction of impoundments. Approximately 48 percent of grassland breeding birds are of conservation concern and 23 species are significantly declining in number. Approximately 22 percent of area-dependent woodland birds are of conservation concern. These numbers have declined by 10 percent through 1980 but have shown some increases in recent years (North American Bird Conservation Initiative 2009). Habitats used by these species have been modified largely by urban development and agricultural practices.

In general, gulls, wading birds, waterfowl, raptors, game birds, game mammals and nongame wildlife (reptiles, amphibians and small mammals) exhibit stable or increasing numbers throughout the TVA region. Populations of white-tailed deer, wild turkey, coyote, and beaver have shown significant population increases. Species associated with river corridors such as osprey, herons and Canada geese have also shown notable recoveries, largely since the ban of dichlorodiphenyltrichloroethane. This trend is quite noticeable on the Tennessee River, as breeding populations of these species had been relatively scarce in portions of northwest Alabama or northeast Tennessee up to the late 1990s. However, in recent years, breeding populations of these species have expanded into these areas and have become more evenly distributed throughout the Valley. Recent surveys show that shorebirds and waterfowl communities are quite diverse in portions of the Valley, especially during autumn and spring migrations. However, numbers of several species of songbirds continue to decline in the region, especially those typically found in grassland or unfragmented forests (TVA 2011).

3.10.1.1 TVA Lands

While TVA manages lands across the region, most TVA lands are concentrated around its reservoirs. Habitats on TVA lands are just as complex as other lands found throughout the TVA region, supporting diverse communities of wildlife. Wildlife habitat on TVA lands ranges from low quality maintained lawns and disturbed forest fragments around power generating facilities, moderate quality early successional rights-of-way along power lines bordered by forest edges, as well as high quality contiguous blocks of forest along reservoir shorelines. Important habitats found in the Valley include riparian corridors, bluffs, swamps, grasslands, rivers, reservoirs, islands, large unfragmented forested landscapes and karst habitats (TVA 2011).

The construction of the reservoir systems by TVA and USACE created large areas of habitat for waterfowl, herons and egrets, ospreys, gulls and shorebirds, especially in the central and eastern portions of the TVA region where this habitat was limited. Ash and gypsum settling and storage ponds at TVA fossil plants also provide local habitat for these birds and other wetland species. These increases in habitat, as well as the ban on the use of the pesticide DDT, have resulted in large increases in the local populations of several bird species. Both long-term and short-term changes in the operation of the reservoir system affect the quality of habitat for these species, as do impoundment management practices at fossil plants (TVA 2015b).

Riparian habitats associated with the Tennessee River and its tributaries provide important habitats for wildlife. Coupled with unique features such as vernal pools, oxbows, bluffs and islands, these areas provide a diverse array of nesting and foraging habitats for wildlife (TVA 2011).

Open lands are comprised of old-field, pasture, agricultural and other early successional habitats, as well as maintained vegetative areas within industrial areas. Most of these areas have been greatly modified by facility infrastructure, intensive row cropping and timber harvesting. Yet, these habitats also provide needed environment for species favoring early successional habitats (TVA 2011).

Birds commonly observed in these type of disturbed habitats, woodland and/or early successional habitat interspersed with human infrastructure include Carolina wren, tufted titmouse, northern mockingbird, northern cardinal, eastern towhee, eastern bluebird, brown thrasher, field sparrow and eastern meadowlark. Red-tailed hawk and American kestrel also forage along road right of ways (Sibley 2000, LeGrand 2005). Mammals routinely observed in this type of landscape include Virginia opossum, raccoon, eastern cottontail, striped skunk, white-tailed deer, eastern mole, woodchuck and rodents such as white-footed mouse and hispid cotton rat (Whitaker and Hamilton 1998). Common reptiles include black racer, black rat snake and eastern garter snake (LeGrand 2005, Conant and Collins 1998; Niemiller et al. 2013).

Forested habitat in these industrial areas may be too fragmented and isolated to support most common forest animal species. However, birds in small forested areas typically include American crow, Carolina chickadee, tufted titmouse, American goldfinch, blue-gray gnatcatcher, red-bellied woodpecker and downy woodpecker (LeGrand et al. 2007, Sibley

2000). Mammals such as eastern chipmunk and eastern gray squirrel tend to occur in urban woodlands (Whitaker and Hamilton 1998). Amphibian and reptile species that may be found in this habitat include ring-necked snake, gray rat snake, five-line skink, copperhead snake, spring peeper and upland chorus frog (LeGrand 2005, Conant and Collins 1998, Niemiller et al 2013).

Caves are abundant features throughout much of the region, especially in north Alabama, northwest Georgia and the eastern half of Tennessee. These sites provide a unique mixture of microhabitats used by a diverse array of cave-dependent species, some endemic to single cave systems.

3.10.1.2 TVA Coal-Fired Plant Sites

The area evaluated for wildlife impacts from ash impoundment closure is more limited than those represented on a regional basis. Habitats potentially affected by closure activities generally include the existing ash impoundments at each facility, associated water bodies and shoreline habitats, maintained grassed and rip-rapped berms, roads, facility infrastructure and limited areas of old field and forested habitat. Generally, wildlife habitat associated with the ash impoundments and their associated environs is of low quality, as construction, maintenance and continual disturbance from facility operations has impacted most habitat within the industrial facility.

The ash impoundments may periodically support variable numbers of waterfowl, wading birds, shorebirds, gulls and other wildlife. Species that may use maintained impoundment areas and grassed berms include a variety of amphibians, reptiles and mammals that may include water snakes, tree frogs, rodents, eastern chipmunk, eastern gray squirrel, raccoons, opossum, coyotes and deer.

Cave systems, while present within the region, are not present within habitats potentially affected by closure activities.

3.10.2 Environmental Consequences

3.10.2.1 Alternative A – No Action

Under the No Action Alternative, wildlife and wildlife habitats would not be directly or indirectly affected by any project-related actions. No construction activities would be undertaken by TVA that would potentially disturb terrestrial wildlife. Local wildlife populations have become acclimated to plant operations. Therefore, there would be no impacts to wildlife under the No Action Alternative.

3.10.2.2 Alternative B – Closure-in-Place

Under Alternative B, proposed ash impoundment closure would result in some disturbance to potential wildlife habitat of predominantly previously disturbed low quality habitats. Impoundments are generally located within a highly fragmented and disturbed industrial landscape that offers minimal habitat for wildlife. Under this alternative, the resident, common and habituated wildlife found in the project area would continue to opportunistically use available habitats within the project area. During construction, most wildlife present within the project site would likely disperse to adjacent and/or similar habitat. However, the wildlife that can use the early successional habitat used to cover the closed impoundments is expected to return upon completion of the proposed actions. The actions associated with Alternative B are unlikely to affect populations of wildlife species common to the disturbed habitats of coal-fired power plant sites.

Periodic nesting of osprey and other water dependent birds (herons) has historically been observed at a number of TVA coal-fired power plant sites. However, in accordance with TVA wildlife management practices and USFWS requirements, nests have previously been removed from areas potentially affected by closure activities when necessary. As such, no impacts to osprey or other water dependent birds is expected to occur with closure-in-place activities.

Closure activities could result in a loss of marginally suitable waterfowl and wading bird habitat associated with existing ash impoundments. However, other higher quality waterfowl habitat is located elsewhere in the vicinity of the fossil plants as they are generally located on large rivers or lakes. Work activities will be designed so as not to affect heron rookeries or other aggregations of migratory waterfowl and wading birds. Thus, this loss of on-site waterfowl and wading bird habitat would be minor.

Following the construction period, some limited wildlife use of closed impoundments may be expected. Impoundments closed by using either the standard soil cover system or the geosynthetic-protective soil cover system will both be vegetated (grassed cover) and may be expected to provide limited foraging and nesting habitat for grassland species. By comparison, however, the engineered synthetic turf cover system would not provide long term habitat for resident wildlife species. Regardless of the cover system sub-alternative selected however, the actions are not expected to result in a significant change to available suitable habitat for any species common to the project area. Proposed actions are not expected to have significant direct or indirect impacts to the local population of any wildlife species. Impoundments with vegetated covers may have minor and slightly beneficial impacts to wildlife in the long term.

3.10.2.3 Alternative C – Closure-by-Removal

Under Alternative C, TVA will excavate and relocate the CCRs from ash impoundments to either on-site or existing off-site facilities.

Similar to Alternative B, the proposed ash impoundment closure would result in some disturbance to potential wildlife habitat of predominantly previously disturbed low quality habitats. During construction, most wildlife present within the project site would likely disperse to adjacent and/or similar habitat in surrounding areas.

As with Alternative B, closure activities under Alternative C could result in a loss of marginally suitable waterfowl and wading bird habitat associated with existing ash impoundments. However, other higher quality waterfowl and wading bird habitat is located elsewhere in the vicinity of the fossil plants as they are generally located on large rivers or lakes. Work activities will be designed so as not to affect heron rookeries or other aggregations of migratory birds. Thus, this loss of on-site waterfowl and wading bird habitat would be minor.

Periodic nesting of osprey and other water dependent birds (herons) has historically been observed at a number of TVA coal-fired plant sites. However, in accordance with TVA wildlife management practices and USFWS requirements, nests have previously been removed from areas potentially affected by closure activities when necessary. As such, no impacts to osprey or other water dependent birds is expected to occur with closure-in-place activities.

After construction, the potential for forested regrowth within the project area could improve wildlife habitat in the area. Because there would be no maintained cover system in the former impoundment area, following construction these lands may be expected to undergo succession to naturalized habitats that may offer somewhat improved habitat quality as compared to Alternative B.

The actions are not likely to affect populations of wildlife species common to the area under Alternative C. The project is not expected to result in a significant change to available suitable habitat for any species common to the area. Proposed actions are not expected to have significant direct or indirect impacts to the local population of any wildlife species, and those impoundments with vegetated covers may have minor and slightly beneficial impacts to wildlife in the long term.

3.11 Aquatic Ecology

3.11.1 Affected Environment

Most of the major rivers and tributaries in the United States east of the Mississippi originate in the mountains of the Appalachian region. First- through twelfth-order streams (Vannote et al. 1980), ephemeral streams and intermittent streams occur in this region to form major river systems. The TVA region encompasses portions of several of these major river systems including all of the Tennessee River drainage and portions of drainages of the Cumberland, Mobile (primarily the Coosa and Tombigbee rivers) and the Mississippi rivers. These river systems support a large variety of freshwater fishes and invertebrates (including freshwater mussels, snails, crayfish and insects). Due to the presence of several major river systems, the region’s high geologic diversity and the lack of glaciation, the region is recognized as a globally important area for freshwater biodiversity (Stein et al. 2000; TVA 2015b).

Generally, reservoirs in the southeastern United States have an ecological structure and function of biological communities that are linked to water residence time. As with other smaller impoundment types, phytoplankton, periphyton and macrophytes supply most of the organic matter to the food web. Due to fluctuating water levels, phytoplankton production dominates most impoundments; however, rooted and floating macrophytes can dominate where water levels are stable in a reservoir (Wallace et al. 1992). Fish, amphibians, reptiles, birds and mammals are the main groups of vertebrates found in and associated with reservoirs in the southeast during a portion of their life cycle (Wallace et al. 1992). Fish populations are mainly comprised of forage fishes including shads and silversides in reservoirs and sunfishes in impoundments (Noble 1981), while the dominant predators in reservoirs are typically basses (Wallace et al.1992).

Common invertebrate species found in southeastern reservoirs include rotifers, protozoans and crustaceans. Within the benthos of most reservoirs in the southeast, larvae of true midges and oligochaete worms are the dominant macroinvertebrates (Diggins and Thorp 1985). Most of the freshwater mussel species known to occur in the United States are distributed in the southeast, with approximately 182 species in Alabama, 130 species in Tennessee, and 126 species Georgia (Neves et al. 1997). However, many benthic organisms have narrow habitat requirements that are not always met in reservoirs or tailwaters below dams. Farther downstream from dams, the number of benthic species increases as natural reaeration occurs and dissolved oxygen and temperatures rise.

3.11.1.1 The Tennessee River Basin

The Tennessee River drainage basin is the dominant aquatic system within the TVA region, and most TVA coal-fired power plants are within the watershed, including BRF, COF, JSF, KIF and WCF. The construction of the TVA dam and reservoir system has promoted navigation, flood control, power generation and recreation, but has also fundamentally altered both the water quality and physical environment of the Tennessee River and its tributaries. Damming of most of the rivers was done at a time when there was little regard for aquatic resources (Voigtlander and Poppe 1989). Beyond changes in water quality, flood control activities and hydropower generation have purposefully altered the flow regime (the main variable in aquatic systems) to suit human demands (Cushman 1985, TVA 2015a).

TVA has undertaken several major efforts (e.g., TVA's Lake Improvement Plan, Reservoir Release Improvements Plan, and Reservoir Operations Study [TVA 2004]) to mitigate impacts on aquatic habitats and organisms. While these actions have resulted in improvements to water quality and habitat conditions in the Tennessee River basin, the Tennessee River and its tributaries remain substantially altered by human activity.

3.11.1.1.1 Mainstem Reservoirs

The nine mainstem reservoirs on the Tennessee River differ from TVA's tributary reservoirs primarily in that they are shallower, have greater flows and retain the water in the reservoir for a shorter period of time. Facilities located on mainstem reservoirs include COF, KIF, JOF and WCF. Although dissolved oxygen in the lower lake levels is often reduced, it is seldom depleted. Winter drawdowns on mainstem reservoirs are much less severe than tributaries, so bottom habitats generally remain wetted all year. This benefits benthic organisms, but promotes the growth of aquatic plants in the extensive shallow overbank areas of some reservoirs. Tennessee River mainstem reservoirs generally support healthy fish communities, ranging from approximately 50 to 90 species per reservoir. "Good" to excellent sport fisheries exist, primarily for black bass, crappie, sauger, white bass, striped bass, sunfish and catfish. The primary commercial species are channel catfish, blue catfish and buffalo (TVA 2015a).

3.11.1.1.2 Tributary Reservoirs and Tailwaters

Tributary reservoirs are typically deep and retain water for long periods of time. Facilities on tributary reservoirs include BRF (Clinch River) and JSF (Holston River). The results from retention time and water depth include thermal stratification, the formation of an upper layer that is warmer and well oxygenated, an intermediate layer of variable thickness and a lower layer that is colder and poorly oxygenated. These aquatic habitats are simplified compared to undammed streams and fewer species are found. Aquatic habitats in the tailwater can also be impaired due to a lack of minimum flows and low dissolved oxygen levels which may restrict movement, migration, reproduction and the available food supply for fish and other aquatic organisms. Dams on tributary rivers affect the habitat of benthic invertebrates (benthos), which are a vital part of the food chain of aquatic ecosystems. Benthic life includes worms, snails, crayfish, aquatic insects, mussels and clams. However, as mentioned previously, many benthic organisms have narrow habitat requirements that are not always met in reservoirs or tailwaters below dams.

3.11.1.2 Other Drainages in the TVA Region

The other major drainages within the TVA region (the Cumberland, Mobile and Mississippi river drainages) share a diversity of aquatic life equal to or greater than the Tennessee River drainage. As with the Tennessee River, these river systems have seen extensive human alteration including construction of reservoirs, navigation channels and locks. Despite these changes, as with the Tennessee River drainage, remarkably diverse aquatic communities are present in each of these river systems.

Facilities located in these watersheds include ALF on the Mississippi River, CUF and GAF on the Cumberland River), PAF on the Green River/Ohio River and SHF on the Ohio River (TVA 2015a).

3.11.1.3 Site-Specific Information

TVA ash impoundments are utilized as retention basins and in many cases do not provide suitable or stable habitat for aquatic species. As such, this PEIS addresses aquatic ecology in the streams and reservoirs at TVA facilities that are adjacent ash impoundments, or in the immediate vicinity of the impoundments. TVA began a program to monitor the ecological conditions of its reservoirs systematically in 1990. Reservoir (and stream) monitoring programs were combined with TVA's fish tissue and bacteriological studies to form an integrated Vital Signs Monitoring Program (VSMP) (TVA 2009). VSMP activities focus on (1) physical/chemical characteristics of waters; (2) physical/chemical characteristics of sediments; (3) benthic macroinvertebrate community sampling; and (4) fish assemblage sampling (Dycus and Baker 2001). Additional site-specific aquatic ecology information is provided in Part II of this PEIS for selected facilities.

3.11.2 Environmental Consequences

3.11.2.1 Alternative A – No Action

Under the No Action Alternative, TVA will continue to operate ash impoundments at all facilities. Currently, permitted NPDES discharges will remain operational and discharge characteristics will continue to meet required permit limits. Accordingly, project-related environmental conditions for aquatic resources in the project area would not change under the No Action Alternative.

3.11.2.2 Alternative B – Closure-in-Place

Under Alternative B, ash impoundments will be closed in place using one of several acceptable closure options (see Section 2.2). Primary construction activities will be located within the footprint of the existing impoundments. Decanting the ash impoundment prior to construction, followed by the installation of an approved cover system would effectively reduce water inputs to the impoundment, thereby eliminating the NPDES permitted discharge. The wastewater discharges during decanting will meet existing permit limits, and compliance sampling will continue to be performed at the approved outfall structure in accordance with the NPDES permit to demonstrate compliance. Additional monitoring will be undertaken as appropriate to better track discharge constituents.

Because ash impoundments are considered treatment systems and not aquatic habitat, and because laydown areas would avoid encroachment or alteration of streams and waterbodies to the extent practicable, direct impacts to aquatic habitat would primarily be avoided with closure activities. Should minor alterations of surface waters be required to support construction activities (e.g., culverted crossing of stream for construction access road), any activities within areas containing aquatic resources will be appropriately permitted and will utilize approved BMPs.

Indirect impacts to adjacent streams and reservoirs may be associated with storm water runoff due to temporary construction activities associated with site preparation and capping. Any construction activities will adhere to permit limit requirements and will utilize BMPs to minimize indirect effects on aquatic resources during the construction phase. Following the construction phase, care and maintenance of the approved closure system and site-wide management of storm water using appropriate BMPs would minimize indirect impacts to the aquatic community of receiving waters.

3.11.2.3 Alternative C – Closure-by-Removal

Under the Alternative C, TVA proposes to close ash impoundments by removing CCR materials to either an on-site or off-site landfill. Primary construction activities will be located within the footprint of the existing impoundments. Decanting the ash impoundment prior to construction, followed by the excavation and removal of CCR to an approved disposal facility. The wastewater discharges during decanting will meet existing permit limits, and compliance sampling will continue to be performed at the approved outfall structure in accordance with the NPDES permit to demonstrate compliance. The disposal location of CCR may vary by facility; however, landfills will be appropriately permitted and maintained and would utilize BMPs and adhere to permit limit requirements.

Because ash impoundments are considered treatment systems and not aquatic habitat, and because laydown areas will avoid encroachment or alteration of streams and waterbodies to the extent practicable, direct impacts to aquatic habitat would primarily be avoided with closure activities. Should minor alterations of surface waters be required to support construction activities (e.g., culverted crossing of stream for construction access road), any activities within areas containing aquatic resources will be appropriately permitted and will utilize approved BMPs. Consequently, no direct impacts to aquatic ecosystems are expected from the closure of ash impoundments by the removal of materials.

Indirect impacts to adjacent streams and reservoirs may be associated with storm water runoff due to temporary construction activities associated with removal activities. Any construction activities will adhere to permit limit requirements and will utilize BMPs to minimize indirect effects on aquatic resources during the construction phase. Following the construction phase, care and maintenance of the former impoundment area coupled with site-wide management of storm water using appropriate BMPs would minimize indirect impacts to the aquatic community of receiving waters.

3.12 Threatened and Endangered Species

3.12.1 Affected Environment

The Endangered Species Act of 1973 (ESA 16 USC §§ 1531-1543) was passed to conserve the ecosystems upon which endangered and threatened species depend and to conserve and recover those species. An endangered species is defined by the ESA as any species in danger of extinction throughout all or a significant portion of its range. A threatened species is likely to become endangered within the foreseeable future throughout all or a significant part of its range. Critical habitats, essential to the conservation of listed species, also can be designated under the ESA. The ESA establishes programs to conserve and recover endangered and threatened species and makes their conservation a priority for federal agencies. Under Section 7 of the ESA, federal agencies are required to consider the potential effects of their proposed action on endangered and threatened species and critical habitats. If the proposed action has the potential to affect these resources, the Federal agency is required to consult with the USFWS.

All seven states in the TVA region have enacted laws protecting endangered and threatened species. In a few states, only species listed under the federal ESA receive legal protection under these laws. In other states, the legal protections also apply to additional species designated by the state. As a federal agency, TVA is not subject to these state laws, but it considers them in its environmental reviews as appropriate.

Thirty-one species of plants, one lichen and 124 species of animals in the TVA region are listed under the ESA as endangered or threatened or formally proposed for such listing by the USFWS. An additional 11 species in the TVA region have been identified by the USFWS as candidates for listing under the ESA. These candidate species receive no statutory protection under the ESA but by definition may warrant future protection. Several areas across the TVA region are also designated as critical habitat essential to the conservation of listed species. In addition to the species listed under the ESA, about 1,600 plant and animal species are formally listed as protected species by one or more of the states or otherwise identified as species of conservation concern (TVA 2015b).

The highest concentrations of terrestrial and aquatic species listed under the ESA occur in the Blue Ridge, Appalachian Plateaus and Interior Low Plateau regions. Relatively few listed species occur in the Coastal Plain and Mississippi Alluvial Plain regions. The taxonomic groups with the highest proportion of species listed under the ESA are fish and mollusks. Factors contributing to the high proportions of vulnerable species in these groups include the high number of endemic species in the TVA region and habitat degradation. River systems in the TVA region with the highest numbers of listed aquatic species include the Tennessee, Cumberland and Coosa Rivers (TVA 2015b).

At least 16 species listed or proposed for listing under the ESA occur on or very near TVA generating facility reservations (TVA 2015b). These include the following:

- Large-flowered skullcap (*Scutellaria montana*) – Threatened
- Ruth's golden aster (*Pityopsis ruthii*) – Endangered
- Gray bat (*Myotis grisescens*) – Endangered
- Northern long-eared bat (*Myotis septentrionalis*) – Threatened
- Indiana bat *(Myotis sodalis)* – Endangered
- Dromedary pearlymussel (*Dromus dromas*) – Endangered
- Fanshell (*Cyprogenia stegaria*) – Endangered
- Pink mucket (*Lampsilis abrupta*) – Endangered
- Ring pink (*Obovaria retusa*) – Endangered
- Rough pigtoe (*Pleurobema plenum*) – Endangered
- White wartyback (*Plethobasis cicatricosus*) – Endangered
- Fluted Kidneyshell (*Ptychobranchus subtentum*) – Endangered
- Rabbitsfoot (*Quadrula cylindrica* – Threatened
- Slabside pearlymussel (*Lexingtonia dolabelloides* – Endangered
- Spectaclecase (*Cumberlandia monodonta*) – Endangered
- Anthony's river snail (*Athernia anthonyi*) – Endangered

3.12.2 Environmental Consequences

3.12.2.1 Alternative A – No Action

Under the No Action Alternative, TVA will not close ash impoundments at any of the coal-fired plants, but TVA eventually will cease using them as it changes from wet CCR management systems to dry systems. Threatened and endangered species would not be impacted under this alternative.

3.12.2.2 Alternative B – Closure-in-Place

Closure-in-Place impacts would be limited to the ash impoundments (permanent impacts) and construction laydown areas (temporary impacts). With this alternative, ash impoundments will be filled/graded, covered, and restored with herbaceous cover or engineered turf. Laydown areas will be temporarily used for material/equipment staging during construction and subsequently restored to existing conditions. Ash impoundments are located in areas currently used for industrial purposes, and necessary borrow material would be obtained from previously permitted sites. Because the areas of permanent and temporary use impacted by this action are already highly disturbed, impacts to threatened and endangered species are not anticipated. If trees are removed as part of this action, the site will be evaluated for potential bat roost suitability followed by consultation with the USFWS if appropriate. Using this approach, trees will be removed in accordance with established USFWS guidelines thus avoiding or minimizing impacts to listed bat species. For sites that require limited tree removal, potential impacts to threatened and endangered species would be minor.

3.12.2.3 Alternative C – Closure-by-Removal

In this closure alternative, CCR material will be entirely removed and the impoundment filled/graded with earthen material prior to restoration with native plants. Because the areas of permanent and temporary use impacted by this action are already highly disturbed, impacts to threatened and endangered species are not anticipated. If trees are removed as part of this action, the site will be evaluated for potential bat roost suitability followed by consultation with the USFWS if appropriate. Using this approach, trees will be removed in accordance with established USFWS guidelines thus avoiding or minimizing impacts to listed bat species. For sites that require limited tree removal potential impacts to threatened and endangered species would be minor.

3.13 Wetlands

3.13.1 Affected Environment

The USACE regulates the discharge of fill material into waters of the United States, including wetlands pursuant to Section 404 of the CWA (33 USC 1344). Additionally, Executive Order (EO) 11990 (Protection of Wetlands) requires federal agencies to avoid, to the extent possible, adverse impact to wetlands and to preserve and enhance their natural and beneficial values. Additionally, under the CCR Rule EPA recognized the sensitivity of wetland environments and adopted a prohibition on locating all CCR surface impoundments and new CCR landfills, as well as lateral expansions of existing CCR units, in wetlands (EPA 2015).

As defined in the Section 404 of the CWA, wetlands are those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas.

Wetlands and wetland fringe areas can also be found along the edges of many watercourses and impounded waters (both natural and man-made). Wetland habitat provides valuable public benefits including flood storage, erosion control, water quality improvement, wildlife habitat and recreation opportunities.

Wetlands occur across the TVA region and are most extensive in the south and west where they comprise 5 percent or more of the landscape (TVA 2015a). Wetlands in the TVA region consist of two main systems: palustrine wetlands such as marshes, swamps and bottomland forests dominated by trees, shrubs and persistent emergent vegetation; and lacustrine wetlands that are associated with lakes and reservoirs such as aquatic bed wetlands (Cowardin et al. 1979). Riverine wetlands associated with moving water within a stream channel are also present. The TVA reservoir system includes almost 200,000 ac of wetlands, which are more prevalent on mainstem reservoirs and tailwaters rather than tributary reservoirs and tailwaters (TVA 2015a). The most abundant type of wetland in this area is forested, while other types include aquatic beds and flats, ponds, scrub/shrub wetlands and emergent wetlands.

Emergent wetland habitat may occur on TVA generating facility sites, often in association with ash disposal and water treatment impoundments. The recently issued Clean Water Rule (80 Federal Register 37053) confirmed that waste treatment systems are excluded from the definition of waters of the United States under Section 404 of the CWA. While excluded from regulation under CWA Section 404, these impoundments can have ecological value such as providing wildlife habitat.

3.13.2 Environmental Consequences

3.13.2.1 Alternative A – No Action

Under the No Action Alternative, TVA will not close ash impoundments at any of the coal-fired power plants. There would be no direct impact to wetland resources as no alterations or construction activities would occur to or near wetlands. Regular maintenance of berms at the ash impoundments would not generally affect emergent wetlands along the fringe of an impoundment as maintenance includes mowing, filling in animal burrows and other similar activities.

3.13.2.2 Alternative B – Closure-in-Place

Ash impoundments are located in areas currently used for industrial purposes and necessary borrow material would be obtained from previously permitted sites. At a given TVA site, an ash impoundment may include an open water area with surrounding wetland fringe habitat. Closure of the impoundment in-place will include draining impounded water, filling the impoundment with material and restoring the site with native herbaceous vegetation or engineered turf system. While the impoundment may provide wetland habitat, the ash impoundments are not under the jurisdiction of the USACE and are not considered “jurisdictional waters” subject to regulation under the CWA. Therefore, there would be no direct impacts to regulated wetlands associated with construction activities within ash impoundments. Associated impacts to vegetation and wildlife within these impoundments are discussed in Sections 3.9 and 3.10, respectively. Temporary laydown areas will not be located in wetland areas but in previously disturbed upland areas (e.g., cleared and graded). Borrow material will be obtained from existing permitted areas and wetland impacts, if any, would have been evaluated and addressed during the borrow area permitting process.

Potential temporary indirect impacts resulting from construction activities could include erosion and sedimentation from storm water runoff into adjacent receiving wetland areas. In order to minimize potential indirect impacts to wetlands, TVA will follow standard construction BMPs to reduce the potential for construction related sedimentation. Upon completion of construction activities, the area will be restored to as close to the original state as possible and in accordance with applicable permits.

In some instances, adjacent narrow wetland fringe communities may occur as a result of lateral movement of water (seepage) through the impoundment berms. Other wetlands downstream of the impoundments may receive water from the ash impoundment outlets. In such cases, indirect impacts to adjacent wetlands may occur from closure of the impoundments themselves as this would likely interrupt the source of wetland hydrology. However, based on a review of aerial photography, water released from the impoundment outlets typically flows directly to a stream or larger waterbody such that, if wetlands did exist downstream of the impoundments, their primary source of hydrology is not likely the ash impoundments. Substantial changes in wetland hydrology or hydroperiod are therefore, not expected. Based on the results of site-specific wetland delineation efforts, TVA design and construction teams will avoid wetland resources and where not feasible, will mitigate for any project-related wetland loss as necessary.

Direct impacts to wetlands are not anticipated under the Closure-in-Place alternative. Minor indirect impacts may occur during the construction phase, but those impacts would be minimized through the implementation of BMPs.

3.13.2.3 Alternative C – Closure-by-Removal

As with Alternative B, closure activities under this alternative will result in the elimination of ash impoundments. However, because ash impoundments are not regulated under Section 404 of the CWA, no direct impacts to waters of the United States are anticipated from impoundment closure activities with this alternative. Associated impacts to wildlife and vegetation within these impoundments are discussed in Sections 3.9 and 3.10. All CCR material will be removed and transported to a permitted landfill (either off-site or on-site), thus additional direct impacts to wetland resources would not be incurred. Impacts to wetlands from construction of the temporary laydown areas and/or borrow areas are not expected.

As with Alternative B, indirect construction activities associated with impoundment closure could result in temporary impacts, including sedimentation from storm water runoff during the construction period as well as indirect impacts to adjacent wetlands from ash impoundment decanting. Temporary indirect impacts would be minimized through implementation of construction-phase BMPs. Based on the results of site-specific wetland delineation efforts, TVA design and construction teams will avoid wetland resources and where not feasible, will then mitigate for any project-related wetland loss as necessary.

Direct impacts to wetlands are not anticipated under the Closure-by-Removal Alternative. Minor indirect impacts may occur during the construction phase, but those impacts will be minimized through the implementation of BMPs.

3.14 Socioeconomics and Environmental Justice

The proposed action involves closure of existing ash impoundments at TVA's coal-fired power plants. Following the completion of construction activities, there will be no operational activities. Some routine periodic maintenance activities are expected but these will be minor. Therefore, the assessment of socioeconomic impacts will be limited to construction activities.

Construction activities may result in positive or negative effects on the local or regional economies as well as positive or negative effects on various socioeconomic groups. The purpose of the socioeconomics analysis is to identify the potential effects of the alternatives on the economy and socioeconomic groups, and to identify any potential measures that would be taken to avoid, minimize, or mitigate negative impacts. In addition, an environmental justice analysis was performed consistent with EO 12989. The purpose of the environmental justice analysis is to determine whether ash impoundment closure activities would result in disproportionate negative environmental impacts on low-income households or minorities.

The data used in this analysis is a combination of US Census Bureau (USCB) Census 2010 and the USCB 2013 and 2014 estimated populations. Regional population, economic and employment, income, and minority data for the affected environment were taken from the Integrated Resource Plan (TVA 2015b).

Impacts to community services and facilities such as cemeteries, churches, primary and secondary education facilities, electricity, fire and emergency medical services, hospitals and police, are normally analyzed in the environmental review of large projects or for major modifications to existing facilities.

3.14.1 Affected Environment

TVA provides electric power or has large generating facilities in a service area that encompasses 178 counties in a seven-state region (Figure 3-5). The estimated population of the TVA PSA was 9.74 million in 2013 (TVA 2015b). This represents a 16 percent increase over the 2000 population (approximately 8.40 million) and a 1.9 percent increase over the 2010 population (approximately 9.56 million). The rate of increase from 2000 to 2013 is greater than the 13.4 percent increase for the United States as a whole and the 14.3 percent increase for the Southern U.S. The 2010-2013 rate of increase for the TVA region is lower than both the national rate of 2.5 percent and the rate for the Southern United States of 3.3 percent. The annual rate of population growth in the TVA region is expected to continue to decline to about 0.5 percent by 2043 (TVA 2015b).

Population varies greatly among the counties in the service area (see Figure 3-5). The larger population concentrations tend to be located along major river corridors: the Tennessee River and its tributaries from northeast Tennessee through Knoxville and Chattanooga into north Alabama; the Nashville area around the Cumberland River; and the Memphis area on the Mississippi River. Low population counties are scattered around the region, but most are in Mississippi, the Cumberland Plateau of Tennessee, and the Highland Rim of Tennessee and Kentucky.

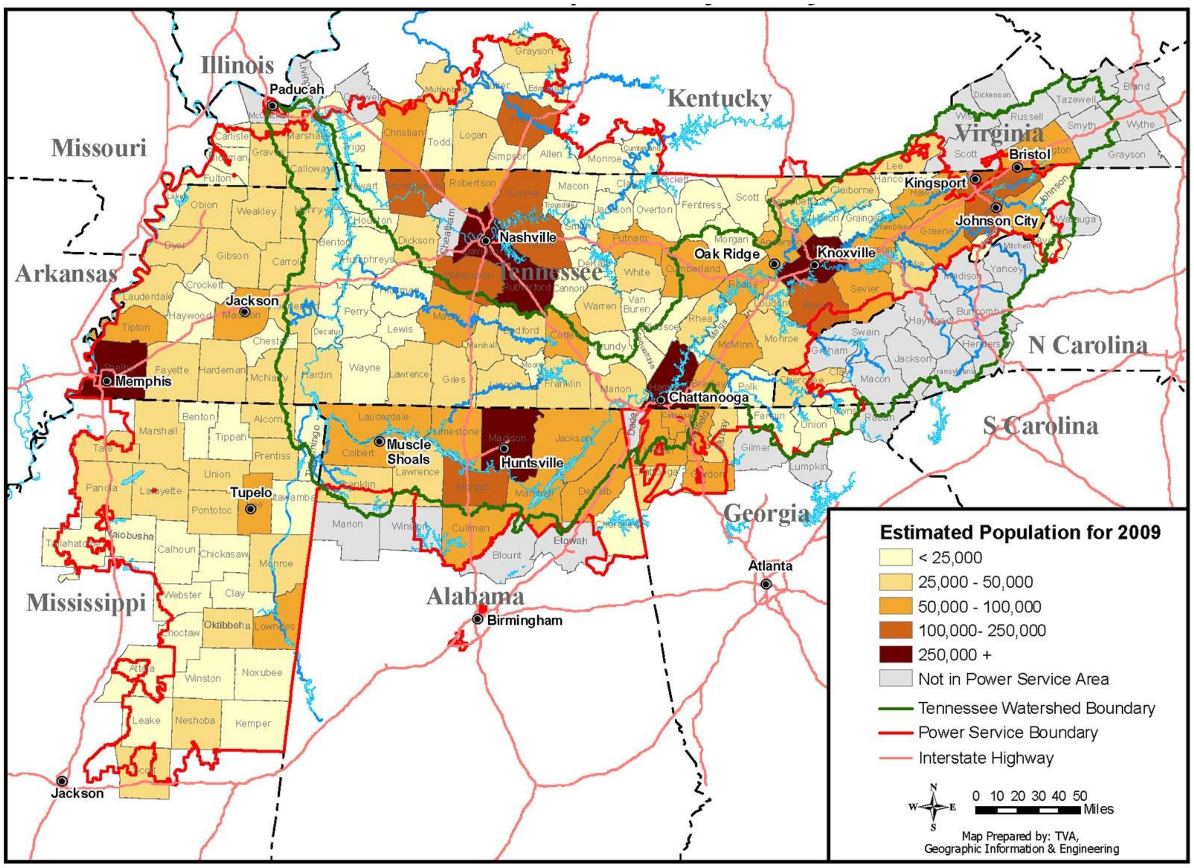

Figure 3-5. TVA Region Estimated 2009 Population by County, TVA 2015

TVA has operated coal-fired plants in 11 counties within the TVA service area. Given the scale of the closure activities, it is likely that any socioeconomic impacts would occur on a local rather than regional scale. Therefore, where applicable, the affected environment for socioeconomics is the geographic areas specific to the locations of TVA coal-fired power plants as this scale provides a more effective definition for socioeconomic factors that may be affected by the proposed action. Socioeconomic characteristics of the 11 counties and cities near the location of TVA coal-fired power plants is summarized in Tables 3-8 through 3-10.

Table 3-8. Summary of Demographic Data for Counties in Alabama and Kentucky Near TVA Coal-Fired Plants

Demographic Characteristic	Alabama			Kentucky		
	Colbert County	Jackson County	State Totals	McCracken County	Muhlenberg County	State Totals
Population						
Population, 2014 Estimate	54,543	52,665	4,849,377	65,316	31,207	4,413,457
Population, 2013 Estimate	54,499	52,944	4,833,996	65,380	31,244	4,399,583
Population (2010)	54,428	53,227	4,779,736	65,565	31,499	4,339,367
Percent Change (2010-2014)	0.2%	-1.1%	1.4%	-0.4%	-0.9%	1.7%
Percent Change (2010-2013)	0.1%	-0.5%	1.1%	-0.3%	-0.8%	1.4%
Persons Under 5 Years (2013)	5.7%	5.4%	6.1%	5.8%	5.1%	6.3%
Persons Under 18 years (2013)	21.7%	22.0%	23.0%	21.8%	21.1%	23.1%
Persons 65 Years Over (2013)	18.1%	18.1%	14.9%	17.8%	17.5%	14.4%
Racial Characteristics						
White Alone (2013)*	80.8%	91.8%	69.8%	85.7%	93.5%	88.5%
Black or African American Alone (2013)*	16.4%	3.4%	26.6%	11.0%	5.0%	8.2%
American Indian and Alaska Native Alone (2013)*	0.6%	1.6%	0.7%	0.3%	0.2%	0.3%
Asian Alone (2013)*	0.5%	0.5%	1.3%	0.9%	0.2%	1.3%
Native Hawaiian and Other Pacific Islander Alone (2013)*	0.0%	0.1%	0.1%	0.0%	0.0%	0.1%
Two or More Races (2013)	1.6%	2.6%	1.5%	2.1%	1.1%	1.7%
Hispanic or Latino (2013)†	2.5%	2.8%	4.1%	2.3%	1.4%	3.3%
Economic Characteristics						
Per Capita Income in Past 12 months (2013 dollars)	$21,572	$20,486	$23,680	$25,957	$20,008	$23,462
Median Household Income (2009-2013)	$39,077	$37,634	$43,253	$44,898	$38,105	$43,036
Persons Below Poverty Level (2009-2013)	17.9%	16.0%	18.6%	16.2%	20.4%	18.8%
Housing						
Housing Units (2013)	25,957	24,599	2,189,938	31,218	13,585	1,936,565
Homeownership Rate (2009-2013)	72.1%	75.2%	69.7%	68.1%	79.1%	68.4%
Median Value of Owner-Occupied Housing Units (2009-2013)	$99,300	$93,400	$122,500	$117,200	$79,500	$120,400
Households, 2009-2013	22,260	20,765	1,838,683	27,037	11,869	1,694,996
Persons per Household, 2009-2013	2.4	2.5	2. 5	2.4	2.5	2.5

Source: USCB State and County QuickFacts 2014

* Includes persons reporting only one race

† Hispanics may be of any race, so also are included in applicable race categories.

Table 3-9. Summary of Demographic Data for Counties in Tennessee Near TVA Coal-Fired Plants

Demographic Characteristics	Anderson County	Hawkins County	Houston County	Tennessee Humphreys County	Roane County	Shelby County	Sumner County	State Totals
Population, 2014 Estimate	75,528	56,735	8,267	18,135	52,748	938,803	172,706	6,549,352
Population, 2013 Estimate	75,494	56,831	8,295	18,245	52,971	939,365	169,114	6,497,269
Population, 2010	75,129	56,833	8,426	18,538	54,181	927,644	160,645	6,346,105
Percent Change (2010-2014)	0.5%	-0.2%	-1.9%	-2.2%	-2.6%	1.2%	7.5%	3.2%
Percent Change (2010-2013)	0.5%	0%	-1.6%	-1.6%	-2.2%	1.3%	5.3%	2.4%
Persons Under 5 years (2013)	5.3%	5.1%	5.2%	5.6%	4.6%	7.2%	6.0%	6.2%
Persons Under 18 years (2013)	21.1%	21.3%	22.0%	22.0%	20.0%	25.7%	24.5%	23.0%
Persons 65 Years Over (2013)	18.5%	18.7%	19.2%	18.6%	20.6%	11.2%	14.2%	14.7%
White Alone (2013)*	92.2%	96.6%	94.4%	94.9%	94.6%	42.6%	89.8%	79.1%
Black or African American Alone (2013)*	4.2%	1.5%	3.0%	2.8%	2.7%	53.1%	6.9%	17.0%
American Indian and Alaska Native Alone (2013)*	0.4%	0.3%	0.3%	0.6%	0.4%	0.3%	0.3%	0.4%
Asian Alone (2013)*	1.2%	0.5%	0.4%	0.4%	0.6%	2.5%	1.3%	1.6%
Native Hawaiian and Other Pacific Islander Alone (2013)*	0.0%	0	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%
Two or More Races (2013)	1.9%	1.1%	1.9%	1.3%	1.7%	1.4%	1.6%	1.7%
Hispanic or Latino (2013)†	2.4%	1.3%	2.2%	2.0%	1.6%	5.9%	4.2%	4.9%
Per Capita Income in Past 12 Months (2013 Dollars)	$24,561	$20,662	$18,539	$22,183	$23,936	$25,549	$27,795	$24,409
Median household income (2009-2013)	$43,620	37357	$35,271	$42,846	$42,223	$46,250	$55,509	$44,298
Persons below poverty level (2009-2013)	18.2%	16.2%	23.5%	13.9%	15.0%	20.8%	10.4%	17.6%
Housing Units (2013)	34,591	26,673	4,146	8,833	25,496	401,149	67,143	2,840,914
Homeownership Rate (2009-2013)	68.5%	76.9%	70.1%	77.8%	74.4%	59.2%	72.9%	67.8%
Median Value of Owner-Occupied Housing Units (2009-2013)	$127,000	$108,900	$87,300	$108,000	$120,300	$132,700	$176,600	$139,200
Households, 2009-2013	30,548	23,348	3,423	7,396	22,117	343,517	60,835	2,475,195
Persons per Household, 2009-2013	2.4	2.4	2.4	2.5	2.4	2.7	2.7	2.5

Source: USCB State and County QuickFacts 2014

* Includes persons reporting only one race
† Hispanics may be of any race, so also are included in applicable race categories.

Table 3-10. Demographic Characteristics of Cities with TVA Coal-Fired Plants (Alabama, Kentucky, Tennessee)

	Alabama		Kentucky		Tennessee						
Demographic	**Tuscumbia**	**Stevenson**	**Paducah**	**Drakeboro**	**Clinton**	**Rogersville**	**Cumberland City**	**New Johnsonville**	**Harriman**	**Memphis**	**Gallatin**
Population Data											
Population, 2014 estimate	8,529	2,002	24,978	509	9,889	4,406	304	1894	6,219	656,861	33,347
Population, 2013 estimate	8,558	2,018	24,987	509	9,882	4,419	307	1909	6,243	658,508	32,354
Population, 2010	8,423	2,046	25,024	515	9,841	4,427	311	1960	6,350	646,889	30,278
Percent change 2010-2014	1.2%	-2.2%	-0.2%	-1.2%	0.5%	-0.5%	-2.3%	-3.5%	-2.1%	1.5%	9.2%
Percent change 2010-2013	1.6%	-1.4%	-0.1%	-1.2%	0.4%	-0.2%	-1.3%	-2.77%	-1.7%	1.8%	6.4%
Persons under 5 years, 2009-2013	5.1%	3.2%	7.0%	6.0%	4.2%	4.4%	12.1%	6.0%	8.3%	7.5%	7.5%
Persons under 18 years, 2009-2013	21.90%	24.6%	13.6%	28.7%	19.6%	19.3%	29.2%	25.1%	22.9%	25.6%	24.2%
Persons 65 years and over, 2009-2013	21.4%	10.3%	18.6%	12.8%	20.8%	21.9%	9.3%	11.5%	21.4%	10.5%	13.6%
Racial Characteristics											
White alone[1]	76.5%	80.6%	73.3%	90.7%	95.3%	95.4%	59.2%	94.8%	89.7%	30.4%	82.3%
Black or African American alone[1]	19.5%	14.6%	21.2%	8.9%	2.0%	2.6%	26.6%	0.9%	4.9%	63.0%	14.5%
American Indian and Alaska Native alone[1]	0.7%	0.0%	0.5%	0.0%	0.0%	1.3%	0.4%	0.4%	0.0%	0.2%	0.1%
Asian alone[1]	0.0%	0.4%	0.5%	0.0%	0.7%	0.0%	0.0%	0.5%	0.7%	1.7%	0.7%
Native Hawaiian and Other Pacific Islander alone[1]	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Two or More Races	3.3%	4.0%	4.2%	0.4%	1.7%	0.7%	13.8%	1.8%	4.0%	1.7%	0.6%
Hispanic or Latino[2]	1.0%	1.9%	2.2%	1.0%	1.4%	0.2%	0.9%	2.1%	3.1%	6.4%	8.2%
Economic Characteristics											
Per capita money income in past 12 months (2013 dollars)	$21,016	$18,795	$22,984	$17,004	$21,829	$16,913	$12,920	$26,208	$16,405	$21,454	$26,596
Median household income	$35,545	$34,601	$34,679	$31,458	$40,156	$23,444	$30,000	$55,000	$26,152	$36,912	$46,102
Persons below poverty level	17.5%	21.8%	22.4%	21.9%	12.3%	25.7%	25.6%	9.0%	24.3%	26.9%	14.4%
Housing											
Housing units	4,163	1,059	13,067	259	4,550	2,356	233	806	3,515	294,641	13,353
Homeownership rate	63.7%	63.2%	49.3%	89.6%	59.8%	48.4%	60.1%	81.7%	59.0%	51.1%	57.9%
Median value of owner-occupied housing units	$92,600	$79,300	$100,900	$55,000	$128,100	$103,500	$68,300	$100,800	$85,400	$95,900	$159,000
Households	3,709	935	11,186	201	4,322	2,356	178	726	2,586	245,182	12,083
Persons per household	2.2	2.5	2.1	2.7	2.2	2.2	3.5	2.7	2.3	2.6	2.5

[1] Includes persons reporting only one race

[2] Hispanics may be of any race, so also are included in applicable race categories.

Source: USCB State and County QuickFacts 2014 and USCB American Community Survey 2009-2013

3.14.1.1 Demographics

An increasing proportion of the region's total population (66.1 percent in 2000, 68.1 percent in 2010 and 68.6 percent in 2013) live in metropolitan areas. Five of the counties with TVA coal-fired power plants are located in metropolitan areas.

- ALF is located in the Memphis, Tennessee metropolitan area.
- COF is located in the Florence-Muscle Shoals, Alabama metropolitan area.
- JSF is located in the Kingsport-Bristol, Bristol, Tennessee-VA metropolitan area.
- KIF is located in the Knoxville, Tennessee metropolitan area.
- GAF is located in the Nashville, Davidson, Murfreesboro, Franklin metropolitan area.

Although some plants are included within the boundaries of the metropolitan areas, the coal-fired power plants are generally located in the more remote, less populated regions of these metropolitan areas.

Current estimates of population within counties outside of the metropolitan areas range from a high of 75,528 in Anderson County, Tennessee to a low of 8,267 in Houston County, Tennessee. As with the coal-fired power plants located in the metropolitan areas, plants outside of metropolitan areas are generally located in less populated areas of the county.

In general, population growth in the 11 counties with coal-fired power plants has remained relatively steady. Between 2010 and 2014, population increases in the counties ranged from 0.2 percent in Colbert County, Alabama to 7.0 percent in Sumner County, Tennessee. During this same period, population increases in nearby cities ranged from 0.5 percent in Clinton, Kentucky to 9.2 percent in Gallatin, Tennessee. Population losses during this period ranged from a low 0.2 percent in Hawkins County, Tennessee to a 2.7 percent loss in Roane County, Tennessee. Population losses in the nearby cities ranged from a low of 0.2 percent in Paducah, Kentucky to a loss of 3.5 percent in New Johnsonville, Tennessee. These numbers are comparable to overall population growth in Tennessee, Alabama and Kentucky; each of which experienced modest population growth during that time period. In contrast, there was a notable increase in population from 2010 to 2014 in the area around GAF. The population of Sumner County increased by 7.5 percent during this period and the population of Gallatin, Tennessee, located within 5 mi northwest of GAF increased by 9.25 percent.

A household includes all the persons who occupy a housing unit as their usual place of residence (USCB 2015). A household may consist of a person living alone or multiple unrelated individuals or families living together. The number of households in the 11-county area ranges from 3, 423 in the county with the lowest population (Houston County, Tennessee) to 343, 517 in the county with the highest population (Shelby County, Tennessee) (see Tables 3-8 and 3-9). The average household size in the 11-county area is 2.5 persons. These trends are also reflected in the data for cites near the coal-fired power plants (see Table 3-10).

The minority population (i.e., all non-white racial groups combined and Hispanic or Latino) of the region, as of 2013, is estimated to be about 2.4 million or 24.5 percent of the region's total population of about 9.7 million (TVA 2015b). This is well below the national average minority population of 37.4 percent. About 4.5 percent of minorities in the region are white Hispanic and the rest are nonwhite. Minority populations are largely concentrated in the metropolitan areas in the western half of the region and in rural counties in Mississippi and western Tennessee.

Racial characteristics in the 11 counties which include coal-fired plants are primarily white which is similar to the state-wide values for Alabama, Kentucky and Tennessee (see Tables 3-8 and 3-9), except for Shelby County, Tennessee where minority populations (specifically black or African American) represent 53 percent of the population. This statistic is also reflected in the data for the cities near the coal-fired plants (see Table 3-10). These populations are primarily white except for the city of Memphis, where black or African Americans comprise 63 percent of the population. Other minority racial and ethnic groups present in the 11-county area and selected cities are generally at or below comparative rates for corresponding counties and states.

The estimated poverty level for the TVA region, as of 2013, is 18.5 percent, an increase from 15.8 percent in 2008 and higher than the 2013 national poverty level of 15.8 percent (TVA 2015). Poverty rates in the 11-county area range from a low of 13.9 percent in Humphreys County, Tennessee to 23.5 percent in Houston County, Tennessee (see Table 3-8 and 3-9). For cities near the fossil-fuel plants, poverty rates range from 9 percent in New Johnsonville, Tennessee to almost 27 percent in Memphis, Tennessee. Poverty rates for Alabama, Kentucky and Tennessee are 18.6 percent, 18.8 percent and 17.6 percent, respectively (see Table 3-10).

There are over 330,000 housing units in cites proximate to the TVA coal-fired power plants (see Table 3-10). Over half of the housing units are owner-occupied, except in Paducah, Kentucky and Rogersville, Tennessee where the homeownership rate is slightly below 50 percent. Median household values range from a high of $159,000 in the Gallatin, Tennessee to a low of $55,000 in Drakeboro, Kentucky. The average median housing value in the cities near the coal-fired plants is $94,317, which is lower than the corresponding median value for Alabama, Kentucky and Tennessee ($127,367) (Tables 3-8 and 3-9).

It is anticipated that the local workforce would be utilized to complete ash impoundment closure and perform maintenance activities so there would be no need for transient housing. Considering the relative size of the anticipated workforce, if some short-term accommodations are needed, existing hotels and motels would be available.

3.14.1.2 Economic Conditions

Manufacturing employment comprises about 11 percent of employment in the TVA region. The service sector is also a significant share of the regional economy. The service sector and other non-farming, non-manufacturing sectors of the regional economy have continued to grow, increasing by about 21 percent and 9 percent, respectively, in the region since 2000. Farm employment comprises about 3 percent of regional employment (TVA 2015b).

The total labor force within the 11 counties that contain TVA coal-fired power plants is 719,275 (Table 3-11). Occupations providing the greatest employment include those that involve production and transportation and office and administrative services. Occupations employing the least number of people in the selected counties include protective services, personal services and computer, engineering and science related occupations.

Table 3-11. Occupational Characteristics

	Management and Business	Computer, Engineering and Science	Education, Legal, Arts and Social	Healthcare and Healthcare Support	Protective Services	Food preparation and Service	Construction and Maintenance	Personal care Services	Sales	Office and Administrative Support	Natural Resources	Production and Transportation	Total Employed Population
Alabama													
Colbert County													
Employees	2,095	554	1,680	2,067	395	1,184	880	420	2,277	2,976	2,399	4,543	**21,470**
Percent	9.8%	2.6%	7.8%	9.6%	1.8%	5.5%	4.1%	2.0%	10.6%	13.9%	11.2%	21.2%	100.0%
Jackson County													
Employees	1,712	669	1,776	1,793	552	1,015	754	543	1,732	2,569	2,968	5,163	**21,246**
Percent	8.1%	3.1%	8.4%	8.4%	2.6%	4.8%	3.5%	2.6%	8.2%	12.1%	14.0%	24.3%	100.0%
Kentucky													
McCracken County													
Employees	3,260	1,180	2,679	2,919	591	2,097	1,051	806	3,480	4,000	2,566	3,890	**28,519**
Percent	11.4%	4.1%	9.4%	10.2%	2.1%	7.4%	3.7%	2.8%	12.2%	14.0%	9.0%	13.6%	100.0%
Muhlenberg													
Employees	777	261	1,436	1,141	491	498	337	295	887	1,197	1,658	2,601	**11,579**
Percent	6.7%	2.3%	12.4%	9.9%	4.2%	4.3%	2.9%	2.5%	7.7%	10.3%	14.3%	22.5%	100.0%
Tennessee													
Anderson County													
Employees	3,556	2,684	2,678	2,663	594	1,739	1,361	813	3,602	4,553	2,853	4,044	**31,140**
Percent	11.4%	8.6%	8.6%	8.6%	1.9%	5.6%	4.4%	2.6%	11.6%	14.6%	9.2%	13.0%	100.0%
Hawkins County													
Employees	1,739	903	1,630	2,741	392	955	714	659	2,076	2,627	2,658	5,201	**22,295**
Percent	7.8%	4.1%	7.3%	12.3%	1.8%	4.3%	3.2%	3.0%	9.3%	11.8%	11.9%	23.3%	100.0%

Table 3-11. Occupational Characteristics

	Management and Business	Computer, Engineering and Science	Education, Legal, Arts and Social	Healthcare and Healthcare Support	Protective Services	Food preparation and Service	Construction and Maintenance	Personal care Services	Sales	Office and Administrative Support	Natural Resources	Production and Transportation	Total Employed Population
Houston County													
Employees	275	24	128	299	43	139	110	63	201	402	746	652	**3,082**
Percent	8.9%	0.8%	4.2%	9.7%	1.4%	4.5%	3.6%	2.0%	6.5%	13.0%	24.2%	21.2%	100.0%
Humphreys County													
Employees	780	109	542	713	171	485	248	221	499	857	1,226	1,632	**7,483**
Percent	10.4%	1.5%	7.2%	9.5%	2.3%	6.5%	3.3%	3.0%	6.7%	11.5%	16.4%	21.8%	100.0%
Roane County													
	2,128	1,438	1,643	1,982	661	988	819	691	2,120	3,079	2,784	3,161	**21,494**
	9.9%	6.7%	7.6%	9.2%	3.1%	4.6%	3.8%	3.2%	9.9%	14.3%	13.0%	14.7%	100.0%
Shelby County													
	59,087	16,529	44,786	31,552	12,054	22,439	18,020	13,209	47,816	64,252	28,570	59,348	**417,662**
	14.1%	4.0%	10.7%	7.6%	2.9%	5.4%	4.3%	3.2%	11.4%	15.4%	6.8%	14.2%	**100.0%**
Sumner County													
	11,681	2,813	8,269	5,767	1,737	4,353	2,291	2,066	9,483	12,540	6,849	9,738	**77,587**
	15.1%	3.6%	10.7%	7.4%	2.2%	5.6%	3.0%	2.7%	12.2%	16.2%	8.8%	12.6%	100.0%

Source: USCB State and County American Community Survey 2013

In November 2014, the average unemployment rate for counties in the TVA region was 6.9 percent. The counties with the highest unemployment rates in the TVA region are somewhat concentrated in east-central Mississippi, in non-urban counties near the Mississippi River, and in the northern Cumberland Plateau in Tennessee. The metropolitan areas generally had lower unemployment rates (TVA 2015).

Unemployment rates for the 11 counties that contain TVA coal-fired power plants are generally lower than the average for the region as a whole. Unemployment rates range from a low of 4.2 percent in Muhlenberg County, Kentucky to a high of 7.6 percent in Shelby County, Tennessee. Unemployment rates in the 11 counties that contain TVA coal-fired plants are summarized in Table 3-12.

Table 3-12. Summary of Employment and Unemployment Data for Counties with TVA Fossil Fuel Plants

County/State	Population >Age 16	Civilian Labor Force	Employed	Unemployed	Percent of Total Population	Percent of Civilian Labor Force
Alabama						
Colbert County	44,170	23,852	21,470	2,382	5.4%	10.0%
Jackson County	42,919	23,648	21,246	2,402	5.6%	10.2%
State Total	3,806,434	2,261,022	2,002,163	258,859	6.8%	11.4%
Kentucky						
McCracken	52,566	31,119	28,519	2,600	4.9%	8.4%
Muhlenberg	25,514	12,655	11,579	1,076	4.2%	8.5%
State Total	3,454,107	2,075,918	1,857,767	218,151	6.3%	10.5%
Tennessee						
Anderson	60,940	34,248	31,140	3,108	5.1%	9.1%
Hawkins	45,721	25,055	22,295	2,760	6.0%	11.0%
Houston	6,611	3,424	3,082	342	5.2%	10.0%
Humphrey	14,714	8,546	7,483	1,081	7.3%	12.6%
Roane	44,088	24,072	21,494	2,578	5.8%	10.7%
Shelby	718,581	472,108	417,662	54,446	7.6%	11.5%
Sumner	127,542	84,178	77,587	6,591	5.2%	7.8%
State Total	5,078,433	3,138,472	2,806,948	331,524	6.5%	10.6%

Source: USCB American Community Survey 2013

Per capita personal income in the TVA region in 2013 averaged $37,463, about 84 percent of the national average of $44,765. While income levels in the region have increased relative to the nation over the past several decades, average income is still below the national level.

Incomes in the TVA region are included on Tables 3-8, 3-9 and 3-10. Average per capita income in the 11-county area is below the regional statistic, $22,841 ($20,193 for the cities near the coal-fired plants). The average median household income is $42,072 ($35,823 for the cities near the coal-fired plants).

3.14.1.3 Environmental Justice

On February 11, 1994, President Clinton signed EO 12898 Federal Actions to Address Environmental Justice in minority and low-income populations. This EO mandates some federal agencies to consider Environmental Justice (EJ) when identifying and addressing disproportionately high and adverse human health or environmental effects of its programs, policies and activities on minority populations and low-income populations. While TVA is not subject to this EO, TVA applies it as a matter of policy.

The analysis of the impacts of ash impoundment closure activities on EJ issues follows guidelines described in the CEQs EJ Guidance under the NEPA (CEQ 1997). The affected area for EJ encompasses the area where potential impacts could occur. The analysis of EJ impacts has three parts:

1. Identification of the geographic distribution of low-income and minority populations in the affected area;
2. An assessment of whether the impacts of closure activities would produce impacts that are high and adverse;
3. If impacts are high and adverse, a determination is made as to whether these impacts disproportionately affect minority and low-income populations.

In the event that impacts are significant, disproportionality will be determined by comparing the proximity of any high and adverse impacts to the locations of low-income and minority populations. If the analysis determines that health and environmental impacts are not significant, there can be no disproportionate impacts on minority and low-income populations.

The CEQ defines minority as any race and ethnicity, as classified by the USCB, as: Black or African American; American Indian or Alaska Native; Asian; Native Hawaiian and Other Pacific Islander; some other race (not mentioned above); two or more races; or a race whose ethnicity is Hispanic or Latino (CEQ 1997). Low-income populations are based on annual statistical poverty thresholds also defined by the USCB.

Identification of minority populations requires analysis of individual race and ethnicity classifications as well as comparisons of all minority populations in the region. Minority populations exist if either of the following conditions is met:

- The minority population of the impacted area exceeds 50 percent of the total population.
- The ratio of minority population is meaningfully greater (i.e., greater than or equal to 20 percent) than the minority population percentage in the general population or other appropriate unit of geographic analysis (CEQ 1997).

The minority population of the region, as of 2013, is estimated to be about 2.4 million; 24.5 percent of the region's total population of about 9.7 million (USACE 2014c). This is well below the national average minority population share of 37.4 percent. About 4.5 percent of minorities in the region are white Hispanic and the rest are nonwhite.

Minority populations are largely concentrated in the metropolitan areas in the western half of the region and in rural counties in Mississippi and western Tennessee (Figure 3-6).

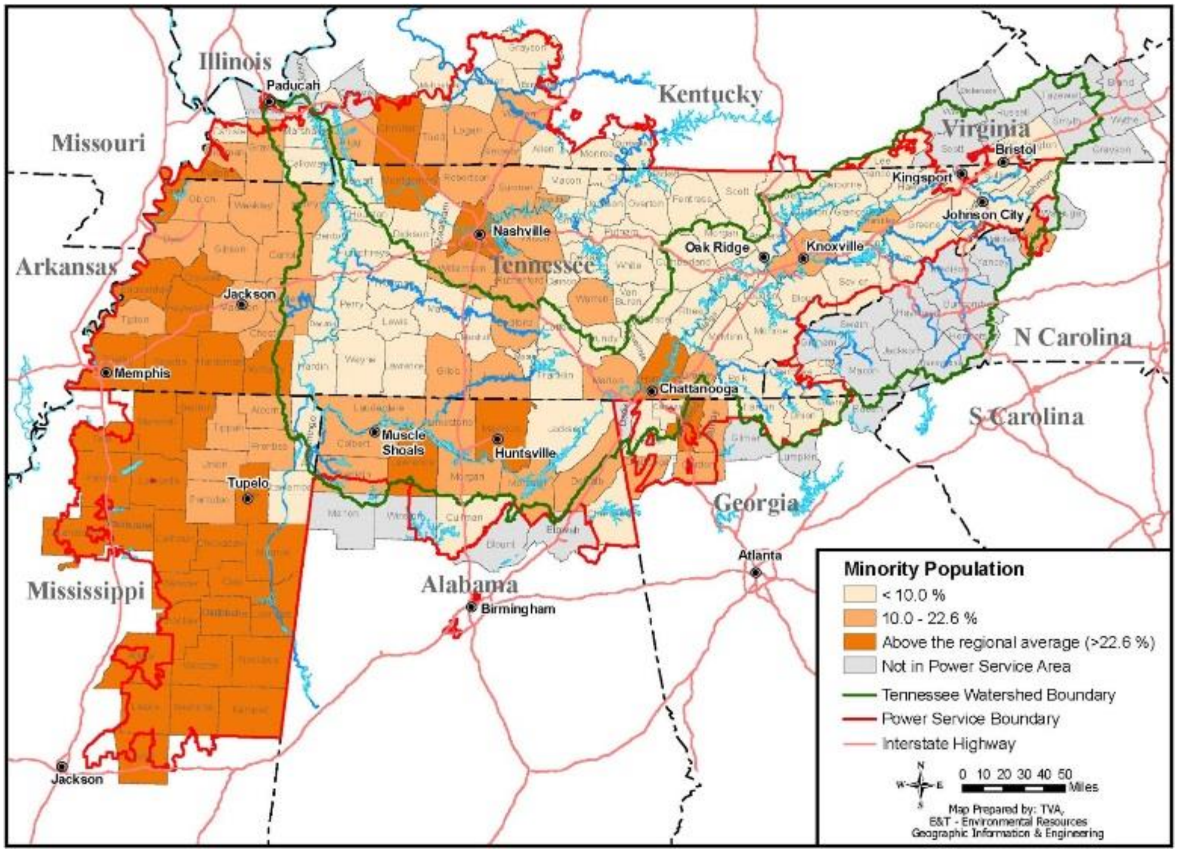

Figure 3-6. Minority Populations within Counties in the TVA Region (TVA 2015)

Low-income populations are those with incomes that are less than the poverty threshold (CEQ 1997). The poverty threshold takes into account family size and the age of individuals in a family. In 2014, the poverty threshold for a family of four with two children below the age of 18 was $24,008 (USCB 2015). A low-income population is identified if either of the following two conditions are met:

- The low-income population exceeds 50 percent of the total number of households.
- The ratio of low-income population significantly exceeds (i.e., greater than or equal to 20 percent) the appropriate geographic area of analysis.

The estimated poverty level for TVA region counties, as of 2013, is 18.5 percent, an increase from the 15.8 percent in 2008 and higher than the 2013 national poverty level of 15.8 percent (USCB 2014d). Counties with the higher poverty levels are generally outside the metropolitan areas and most concentrated in Mississippi (Figure 3-7).

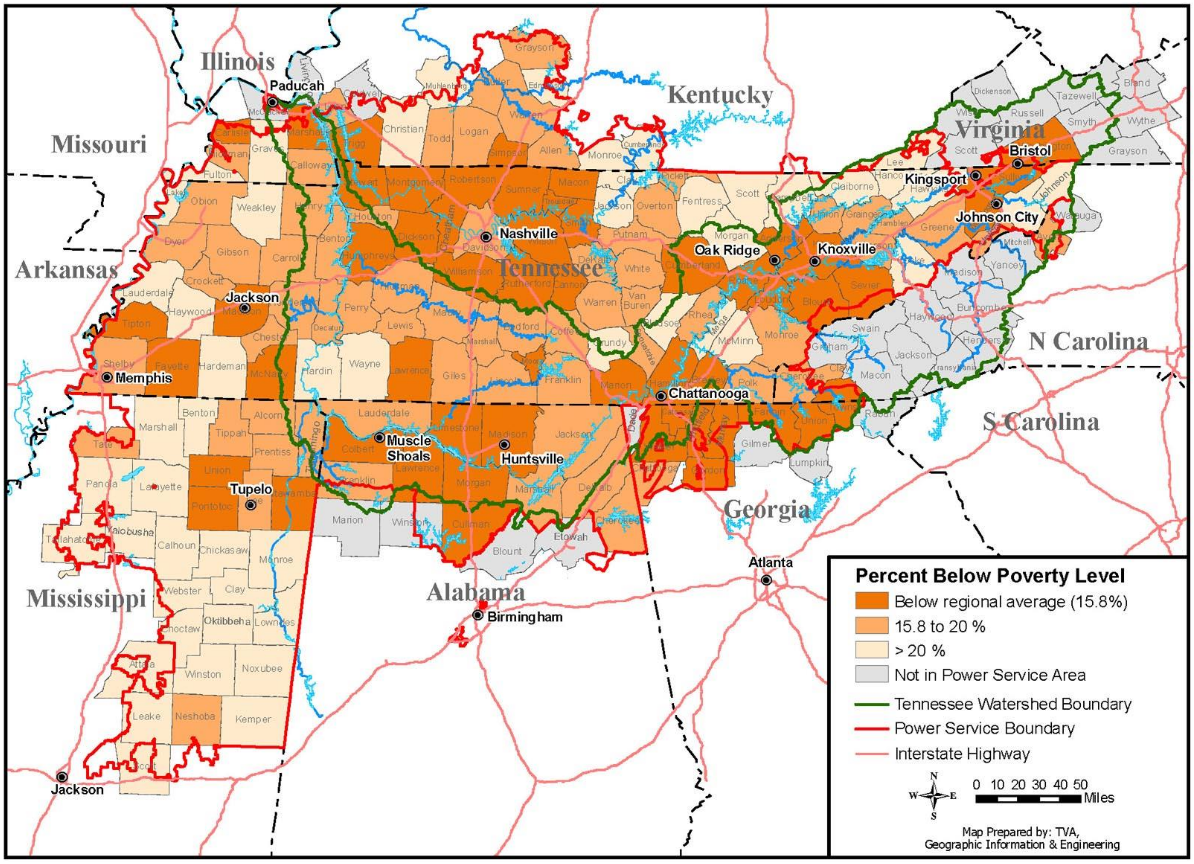

Figure 3-7. Low Income Populations within Counties in the TVA Region (TVA 2015)

3.14.2 Environmental Consequences

3.14.2.1 Alternative A – No Action

Alternative A will involve no changes to the current conditions and generated CCR would continue to be stored in the existing ash impoundments. No additional or new socioeconomic impacts would be associated with this alternative.

3.14.2.2 Alternative B – Closure-in-Place

Demographic characteristics are not expected to change in the areas surrounding ash impoundments. Adverse impacts generally occur when a project displaces residents or businesses or when a large workforce relocates to low population areas with limited labor workforces, community facilities and services and housing. Such adverse impacts are not expected because workforces associated with ash impoundment closure are relatively small and no relocations are anticipated since the required work can be accomplished with the local workforce. In addition, no residences or businesses would be displaced. Therefore, adverse impacts to community facilities and services, housing, local workforces and loss of income are not expected.

Closure activities under this alternative will involve several steps that include, lowering the water level in the ash impoundment, site preparation, transport of borrow material and installation of an approved closure cover system. For purposes of this programmatic analysis, the range of known construction activities (proposed for the impoundments analyzed in the site-specific sections) was used to provide the bounding condition.

The primary socioeconomic impacts are expected to be beneficial in the form of temporary increase in jobs, income, purchases of local goods and services and employment-related tax revenues. Relevant construction data is summarized on Table 2-1. Because ash impoundment sizes vary, the amount of estimated fill material required to cover these impoundments is also expected to be variable. The total estimated closure costs for this alternative range from $3.5 to $150 million, with most of the closures costing less than $50 million. The associated construction work forces required for the closures varies but can include up to 100 workers.

Construction activity related to the Closure-in-Place alternative would require a relatively small number of workers for a short time. This would have a small positive, but temporary, impact on income and employment in the local area.

3.14.2.3 Alternative C – Closure-by-Removal

This alternative will entail lowering the water level in the ash impoundment, removal of CCR, filling-in and contouring and planting of vegetation. Depending on the volume of CCR, these activities may require long periods of time to transport materials to receiving landfills as discussed in Section 2.2. Relevant construction data is summarized on Table 2-3.

Under this alternative, the amount of material that will have to be partially dewatered, excavated and hauled to permitted landfills is very large ranging from 145,500 to 25 million yd^3. The cost of projects ranges from an estimated $15 million to as high as $2.7 billion. The associated construction workforce varies but can include up to 100 workers.

Similar to Alternative B, Alternative C will temporarily create additional jobs, income, purchases of goods and services and tax revenues. Because of the longer construction times that may be required for large ash impoundments for this alternative, the benefits will last for a longer period of time.

Although this alternative is not expected to have any significant adverse impacts on population, community facilities and services, or housing, the potential for adverse impacts to the economy, workforce and equipment resources is potentially much higher than for Alternative B. Depending on the volume of CCR materials to be removed, larger amounts of equipment (especially haul trucks) would be required along with the associated work force needed to operate this equipment. For impoundments with large volumes of CCR, this impact may be long term, rather than short term. Strategies to shorten the duration of the removal effort may be accomplished by increasing the number of trucks. However, it may be expected that such strategies may also place a high demand upon the equipment and workforce availability within the trucking industry which may result in the influx of equipment and operators from a wider geography. Due to an increase number of workers, this resource would have a relatively greater positive impact on income and employment. However, as with Alternative B, this impact would be small and temporary for sites having a low CCR volume, but greater and long term for sites having a large CCR volume.

Although adverse human health or environmental impacts as a result of ash impoundment closures are not anticipated, the identification of low-income and minority populations that may be subject to EJ considerations requires an analysis of specific geographies proximate to the ash impoundment closure site as well as the routes used to haul borrow material and CCR to and from the construction site.

As closure activities will occur on previously developed industrial sites, borrow material will be obtained from a permitted site, and CCR will be disposed in an existing permitted landfill designed to handle waste of this type, direct human health and environmental impacts are not anticipated. Potential environmental justice impacts associated with either closure method would primarily be indirect impacts related to the transport of borrow material and CCR. These activities would result in construction-related noise, exposure to fugitive dust and exhaust emissions to identified EJ communities. For sites with large volumes of CCR, the magnitude of impact would be greater and longer lasting due to increased duration and frequency of off-site trucking.

Fuller consideration of the potential impacts to EJ communities requires consideration of site specific information.

3.15 Natural Areas, Parks and Recreation

3.15.1 Affected Environment

Natural Areas, parks and recreation areas include sites typically managed and/or used for one or more of the following objectives:

- Recreation – Examples include national, state and local parks and recreation areas; reservoirs (TVA and others); picnic and camping areas; birdwatching, trails and greenways; and TVA small wild areas, day use areas and stream access sites.
- Species/Habitat Protection – Places with endangered or threatened plants or animals, unique natural habitats, or habitats for valued fish or wildlife populations. Examples include national and state wildlife refuges, mussel sanctuaries, TVA habitat protection areas and nature preserves.
- Resource Production/Harvest – Lands managed for production of forest products, hunting and fishing. Examples include national and state forests, state game lands and wildlife management areas, and national and state fish hatcheries.
- Scientific/Educational Resources – Lands protected for scientific research and education. Examples include biosphere reserves, research natural areas, environmental education areas, TVA ecological study areas and federal research parks.
- Scenic Resources – Areas with exceptional scenic qualities or views. Examples include national and state scenic trails, scenic areas, wild and scenic rivers and wilderness areas.

Numerous natural areas, parks and recreational facilities occur throughout the seven state TVA region in all physiographic areas. Many managed areas cross state boundaries or are managed cooperatively by several agencies (TVA 2015b). They are most concentrated in the Blue Ridge physiographic area overlapping the western edge of Tennessee and Mississippi Alluvial Plain physiographic area on the eastern edge of Tennessee. Most managed areas and ecologically significant sites have multiple management objectives and if management objectives cannot be met, the integrity of the area may be lost or compromised. Natural areas, parks and recreation sites can vary in size from less than an acre for a boat launching ramp site to thousands of acres for a designated wildlife management area. Several of these areas are located in the vicinity of TVA coal-fired generation plants.

Recreational facilities are also found on some coal-ash plants within the TVA system. These facilities include boat launching ramps, bank fishing areas and walking trails. In addition, the ash impoundments in the TVA system typically contain a large, shallow expanse of water and ash/mud flats which attract a variety of shorebirds, waterfowl and other wading birds. Although the ash impoundments are closed to the public, TVA allows birders to view these sites from the surrounding roads.

3.15.2 Environmental Consequences

3.15.2.1 Alternative A – No Action

Under the No Action Alternative, TVA will not close ash impoundments at any of the coal-fired plants. There would be no direct impact to natural areas, parks or recreation.

3.15.2.2 Alternative B – Closure-in-Place

Ash impoundments are located in areas currently used for industrial purposes and necessary borrow material will be obtained from previously permitted sites. Therefore, there would be no direct impact to natural areas, parks or recreation areas. However, recreational facilities such as boat launching ramps and bank fishing areas are found on several of the TVA facilities. Users of recreational facilities on TVA sites could be directly impacted if these facilities would be closed as a result of closure activities. In many cases, this impact would be temporary as facilities would likely re-open once the impoundments are closed. However, if the facilities remain closed, this impact would be considered a direct long-term impact associated with this alternative. Closure of the ash impoundments will require decanting of surface water and, therefore, these impoundments will no longer attract shorebirds or other waterfowl. This would result in a long-term impact to birders who frequent the area around the impoundments to view shorebirds, waterfowl and other water birds.

There is a potential for indirect impacts associated with construction activities related to closure of the impoundment itself and the transport of borrow material from an off-site location to the construction site. Fugitive dust, noise and traffic generated as a result of these activities could have an indirect impact on users of natural areas, parks and recreational areas located in the vicinity of the construction site. In addition, fugitive dust, noise and traffic generated as a result of transport of borrow material from an off-site location to the impoundment closure site could indirectly impact users of natural areas, parks and recreational facilities located adjacent to the transport route. However, construction-related traffic will utilize interstate or major arterial roadways where possible and BMPs designed to minimize fugitive dust emissions will be employed which would minimize impacts. Therefore, because this impact would be temporary and limited to the construction period and BMPs will be used to minimize the effects from fugitive dust, the effects of this alternative would be minor and would not impair use or enjoyment of these resources.

3.15.2.3 Alternative C – Closure-by-Removal

As with Alternative B, there would be no direct impact to natural areas, parks or recreation as a result of closure activities under this alternative as all ash impoundments are located in industrial areas. All CCR material will be transported to a permitted landfill (either off-site or on-site) and, therefore, there would be no direct impact to natural areas, parks or recreational areas. Users of recreational facilities on TVA properties could be directly impacted if these facilities would be closed as a result of closure activities. In many cases this impact would be temporary as facilities likely would reopen once the impoundments are closed. However, if the facilities remain closed, this impact would be considered a direct long-term impact associated with this alternative. If an ash impoundment attracts shorebirds or other waterfowl, closure of the ash impoundment under this alternative would have a long term impact to recreational birders as these areas will no longer be available.

As with Alternative B, construction activities associated with impoundment closure and the transport of CCR to an off-site landfill could indirectly impact natural areas, parks and recreation sites as a result of increased traffic volumes, noise and fugitive dust generated by construction activities. Transporting CCR to a permitted landfill could also result in an increase in noise, fugitive dust and increased traffic along the haul routes that may impact adjacent receptors. Additionally, because the volume of CCR material within ash impoundments is typically much greater than the volume of borrow material required for Alternative B, the duration of these potential off-site impacts would be substantially greater. Implementation of BMPs will minimize these impacts. Therefore, closure under this alternative may cause minor disturbances during the construction phase for sites having small volumes of CCR, but could result in larger disturbances for sites having large volumes of CCR that may affect use or enjoyment of these resources.

3.16 Transportation

3.16.1 Affected Environment

This section describes the transportation infrastructure that could be affected by the project alternatives. The approach taken in this programmatic section focuses on a regional scale rather than a site-specific scale.

TVA's coal-fired power plants are served by public roadway, railway and/or waterway modes of transportation. Road access to these power plants varies from two-lane roads to four-lane divided highways and is via at-grade intersections, with some of them controlled by traffic signals. Public road managers for this system include state departments of transportation, county highway departments and municipal road departments. Rail lines are managed by large railroad operators such as Union Pacific Railroad and Burlington Northern and Santa Fe Railway (BNSF) in the western part of the PSA, Norfolk Southern Railway (NSR) in the eastern part and CSX Transportation, Inc. (CSX) throughout the PSA. Several short-line and local railroads exist in the PSA as well. Barge operation is present on the Mississippi River, Ohio River, Tennessee River and the Tennessee-Tombigbee Waterway.

3.16.2 Environmental Consequences

3.16.2.1 Alternative A – No Action

Under the No Action Alternative, TVA will not close ash impoundments at any of the coal fired plants. The impoundments will continue to receive storm water and some process water and TVA will conduct regular maintenance on the berms to ensure stability. There would be no direct impact and no change to transportation in the TVA PSA.

3.16.2.2 Alternative B – Closure-in-Place

Under Alternative B, CCR impoundments will be closed in place using an approved closure system (see Section 2.2). Borrow material used in the closure system will be obtained from a previously permitted site either on-site or off-site. Impacts to the transportation system would be associated with the following:

- Equipment/materials mobilization and
- Construction workforce
- Transport of suitable borrow material to the site

All of these actions would be temporary and would extend through the duration of the closure activities.

3.16.2.2.1 Equipment Mobilization and Construction Workforce

The construction workforce traveling to and from a plant site would contribute to the traffic on the local transportation network. A construction workforce of 75 to 100 could be expected to support most ash closure activities under this alternative. This workforce volume would occur at the beginning and ending of the work day. Additional construction-related vehicles (dozers, backhoes, graders, loaders, etc.) would be delivered to each CCR impoundment site on flatbed trailers under both the mobilization and demobilization stages of the project. Overall, the traffic volume generated by the construction workforce and the construction-related vehicles would be relatively minor. It is assumed that these motorists would use interstate highways or major arterial roadways as much as possible,

3.16.2.2.2 Transport of Borrow Material

As described in Section 2.2, roadway transportation of borrow material likely will be the most reasonable and economically viable mode for transport of borrow at all sites. Trucking has the advantage of using the established roadway network and does not require the design, permitting and construction of additional rail loading facilities.

The impacts to transportation would result from increased traffic volumes on roadways between the borrow sites and the impoundment to be closed. It is expected that suitable borrow material would be available within a 30-mi radius of each site.

The amount of borrow material needed at each site will vary, but it is possible that as much as 4,300,000 yd^3 of material would be needed to supply sufficient cover under the Closure-in-Place alternative. Typical borrow material requirements are likely to be between 80,000 and 200,000 yd^3.

Using the estimated largest volume of borrow, it is estimated that up to175 truckloads per day (tandem dump truck) (traffic count of 350 trips passing a single location on a daily basis) would be required to haul borrow material. This is a conservative approach and does not represent the typical range of borrow needed at a site. Table 3-13 presents the relationship between the number of truckloads and the amount of borrow material that can be hauled given an 18-month construction schedule. It is not likely that this would occur over long distances (i.e., 30 mi or more) because as the haul distance gets longer, it would become more cost prohibitive as more trucks would be required to satisfy the truckload requirement. Under shorter haul distances, the same truck could make several trips (truckloads) over the course of a workday. Additionally, a longer haul route would result in an increased risk of traffic accidents and safety issues.

Table 3-13. Borrow Material Transport Capacity for Closure-In-Place Alternative

Number of Truckloads Per Day[1]	Borrow Material (yd^3) (Thousands)[2]
30	170
40	230
50	280
60	340
90	510
120	680
180	1,000
240	1,360
300	1,700
400	2,270
600	3,400
758	4,300
800	4,530

[1]Each truckload results in a truck passing a given location two times (one trip loaded and the return trip unloaded).
[2]Assumes a work duration of 18 months and 15 yds^3 per tandem dump truckload.

As described above, as the haul distance from a borrow site to the project site increases, it would result in the need for more trucks to meet the total truckload demand and required closures schedule.

The volume generated by the trucks hauling borrow material from a borrow site to the ash impoundment site would create a steady traffic stream over the course of an entire work day. For impoundments having a large borrow volume requirement and a short closure schedule (4,300,000 yd^3 in 18 months) this would equate to a traffic count of approximately 168 trips per hour (between 8:00 a.m. and 5:00 p.m.) or three trucks passing a given point approximately every minute. This volume of truck traffic could be expected to result in a deterioration of local traffic operations (the level of service could degrade), and it would have the potential to result in notable deterioration of roadways (particularly less improved local roads). Such impacts may include wear and tear of the pavement, pavement rutting, formation of potholes and destruction of soft (grass or loose gravel) shoulders. Other potential adverse effects may also result from high volumes of haul trucks on public roads such as noise, vibration and visual impacts as described in Section 3.16.

Typical borrow material requirements are likely to be between 80,000 and 200,000 yd^3. As illustrated in Table 3-13, a volume of 227,000 yd^3 is expected to result in approximately 40 truckloads per day over an 18-month (or longer) period. Traffic counts along the haul routes would be expected to be up to 80 vehicles per day for such borrow volumes. It is expected that this would equate to approximately 10 trucks passing by a given location each hour (0.2 trucks per minute). Based on this level of use impacts to traffic operations are expected to be relatively minor. In addition, the impact on the condition of less improved local roads and receptors along the route would be substantially less.

Therefore, given a more typical volume of borrow material need, this alternative may cause minor disturbances to the roadway network, localized roadway degradation and minor potential effects to adjacent environmental receptors from traffic noise, emissions and vibration during the construction phase. However, it would not impair use of these roads by the public. Alternatively, for sites requiring more substantial borrow volumes, the transportation impacts resulting from the implementation of Alternative B would be more notable. As discussed earlier in Chapter 2, there is an increased risk of traffic crashes involving trucks on local roadways. For sites that require larger borrow volumes, the risk for more crashes would increase due to the increased number of trucks traveling along the haul route.

As the number of truck movement miles increase, however, both for Alternative B and Alternative C discussed next, the risk of traffic crashes, including personal injuries and fatalities increase. A September 2013 investigation of heavy truck crashes in Kentucky by the University of Kentucky analyzed crash data for 2008-2012. Annual crashes involving trucks ranged from 7,442 to 9,092 with annual fatalities of 85 to 102. For the five-year period studied for Kentucky, truck crashes accidents represented 6.4 percent of all crashes, 5.5 percent of injury crashes and 12.2 percent of fatal crashes. The statewide crash rate per 100 million vehicle miles (MVM) ranged from 163 to 226. On rural roadways, statewide crash rates ranges from 183 to 217 per 100 MVM on two-lane roadways. Therefore, there is a potential for increased crash rates on roadways being used by heavy trucks to haul borrow.

3.16.2.3 Alternative C – Closure-by-Removal

Under Alternative C, CCR material will be removed from the impoundments and transported to a previously permitted landfill (either off-site or on-site). The former impoundment will be filled/graded and covered with borrow material obtained from a previously permitted site.

The determination of the mode of transport (truck or rail) will be made on a case by case basis. Transport by rail is expected to result in lower impacts to transportation as compared to truck transport. As described in Section 2.2, rail transportation may not be feasible to support the short term closure activities associated with inactive impoundments and for low volume ash impoundments. However, rail transport may be considered as potentially viable for the Closure-by-Removal alternative for impoundments having large volumes CCR and longer term closure schedules.

It is likely that trucking is the most appropriate mode of transportation for removal of CCR under Alternative C for many of the ash impoundment sites. For this programmatic analysis, a 30-mi radius is used as the boundary for transportation impacts. Impacts to the transportation system would be associated with the following:

- Equipment/materials mobilization and
- Construction workforce
- Transport of suitable borrow material to the site
- Truck transport of CCR off-site to a previously permitted landfill

The impacts to transportation associated with the construction workforce and the transport of borrow would be similar to those described above for Alternative B in proportion to the required volume of borrow. However, borrow activities under this alternative are expected to be sequenced after most CCR removal activities. Impacts of removal on the local transportation system and associated traffic are governed by the impacts of the hauling of CCR off the site.

Unlike Alternative B, the Closure-by-Removal Alternative could have a substantially greater volume of truck traffic hauling CCR to a permitted landfill. The amount of CCR at the various TVA plants varies and this variability would affect the number of truckloads from the TVA plant. Two factors would affect the number of trucks needed to satisfy the truckload demand: (1) the haul distance to the landfill; and (2) the timeframe for the hauling. Longer distances or shorter timeframes would generally require more trucks to meet the CCR truckload demand.

The amount of CCR to be hauled off-site varies by ash impoundment. The CCR volumes could range from approximately 145,000 yd^3 to 25 million yd^3 or more. Truck transport of CCR is more cumbersome than hauling borrow material. The CCR material transported off-site will be dried to a reasonable degree to support transport. As a result, the volume of CCR material within a given truck is expected to be notably lower (approximately 10 yd^3 for CCR, 15 yd^3 for borrow material). For sites having a more prolonged schedule, CCR may be stockpiled and allowed to dry prior to transport in trucks, thereby allowing for greater volumes per load.

Additional logistical problems associated with hauling large volumes of CCR to off-site landfills include the following:

1. For inactive ash impoundments or those scheduled for closure within an abbreviated schedule, a very limited time is available to accomplish removal (closure required by April 2018). If it is assumed that removal activities included the use of 100 truck-loads per day, only 380,000 yd^3 of CCR would be removed over an 18-month period (see Table 3-14). Off-site transport of CCR from ash impoundments with larger volumes of CCR would not be feasible within a limited timeframe as illustrated in Figure 2-6.
2. The distance to the receiving landfill is an important factor in evaluating feasibility of the haul-off. Landfills at greater distances from the site would require longer travel times and would require more trucks to satisfy the number of truckloads per day (shorter haul routes mean one truck could make several truckload trips per day).
3. The hauling of CCR off-site creates safety concerns with respect to a higher risk of accidents and spills along the haul route.
4. The availability of resources (drivers, trucks, loaders, equipment) may not exist for a site with larger CCR haul-off volumes.

Table 3-14. CCR Material Transport Capacity for Closure-By-Removal Alternative

Number of Truckloads Per Day	CCR Material (yd^3) (Thousands)[1]
30	115
40	150
50	190
60	230
100	380
120	455
175	660

[1]Assumes a work duration of 18 months and 10 yd^3 per tandem dump truckload.

For sites having a lower volume of CCR (<500,000 yd^3), the hauling off of CCR would be completed prior to the hauling of borrow material to a respective site. It is assumed that there will be 100 truckloads of CCR per day from a site, and there will be 175 truckloads of borrow per day to a site. Therefore, the amount of truckloads of borrow sets the upper limit of haul trips for a site at a given time. This 175 truckloads per day under the Closure-by-Removal alternative would result in approximately 39 trucks passing by a given location each hour (approximately 1 truck every minute and a half). However, even on smaller roads (such as a rural two-lane road with no shoulders), this volume of trucks would not have a substantive impact on traffic operations unless traffic volumes on that two-lane roadway were already causing reduced operational efficiency. The addition of the truck traffic has the potential to lower traffic efficiency if an existing roadway or intersection is at or near capacity. However, most of the TVA service area is rural and the existing traffic volumes are relatively low and these additional truck volumes are not such that they are likely to affect the level of traffic operations.

For sites having large volumes of CCR (>500,000 yd^3) the combined use of trucks hauling off CCR and hauling of borrow material on-site could extend for prolonged periods of time (see Figure 2-7) and/or result in much greater truck volumes. For example, closure of a site having a CCR volume of 3,500,000 yd^3 in two years would result in 350,000 truckloads of CCR (1,300 truck trips per day, Figure 3-8) to a landfill. It is expected that this would equate to approximately 162 trucks passing by a given location each hour (2.7 trucks per minute). For much larger sites having a CCR volume of 25,000,000 yd^3 closure within two years would result in 2,500,000 truckloads of CCR (9,200 truck trips per day, Figure 3-8). It is expected that this would equate to approximately 1,157 trucks passing by a given location each hour. This would increase roadway deterioration substantially compared to Alternative B. Such deterioration would include wear and tear of the pavement, pavement rutting, formation of potholes and destruction of soft (grass or loose gravel) shoulders. This will require maintenance of these roadways over the duration of the hauling operation. As discussed earlier, increased numbers of truck movements also have the potential to result in an increased number of truck-related crashes that is proportional to the number of trips. For sites that required larger CCR and borrow volumes, the risk for more crashes would increase due to the increased number of trucks along the haul route. Other potential adverse effects may also result from high volumes of haul trucks on public roads such as air quality, noise and ground vibration as described in Section 3.16.

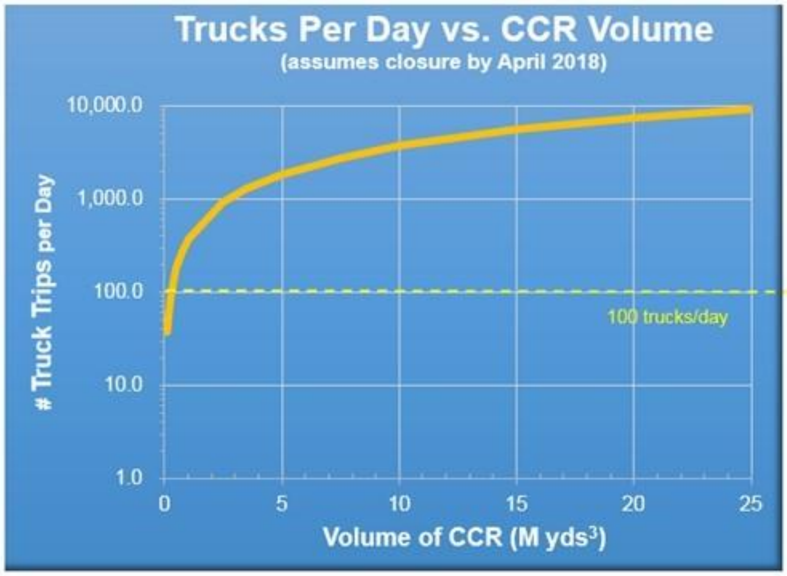

Figure 3-8. Trucking Duration vs. CCR Removal Volume

Therefore, transportation impacts resulting from the implementation of Alternative C are variable and dependent upon both CCR volume to be removed and schedule for impoundment closure.

Rail transport of CCR may also be a viable mode of transportation at some sites. This mode would entail some on-site environmental disturbances associated with the development of loading and staging infrastructure, but will use existing rail lines for transport of CCR materials to receiving landfills. Accordingly, this mode of transport would result in substantially lower impacts as compared to trucking for air and noise emissions, traffic impacts, roadway deterioration and safety.

Use of rail will require loading and unloading infrastructure, and a rail transportation service in the form of a rail carrier. Rail cars dedicated for use as CCR transport would also have to be acquired and provided to support CCR removal operations. Rail facilities may have to be expanded and improved to support CCR loading and unloading operations. An assessment of permitted Subtitle D landfills in Tennessee, Kentucky and Alabama shows that there is a very low percentage of landfills that can accept waste directly by rail. As a result, considerations of use of rail to transport CCR may need to consider disposal sites at more distant locations. Even if a landfill is near a rail line, additional infrastructure would likely need to be developed to support the unloading operations in the vicinity of the receiving landfill. Because the CCR is not likely to be off-loaded directly from rail to a permitted landfill (unless a rail spur is designed, permitted and constructed), some amount of over-the-road trucking will still be needed in most cases to haul the CCR to a landfill. Impacts associated with trucking would be similar to those described above (i.e., air and noise emissions, traffic impacts, roadway deterioration, safety), but more localized in their extent. Substantial environmental impacts (either perceived or real) including potential disproportionate social economic impacts would need to be assessed in conjunction with the placement of CCR at off-site receiving landfills.

The cost effectiveness of shipping by rail is also a factor. Shipments of larger CCR volumes over longer distances can help offset the costs of new infrastructure to load and unload the material. However, shipping by rail becomes less feasible for shipments of larger CCR volumes in a short timeframe. It is also less feasible for shipments of relatively small CCR volumes where the costs to develop the loading and unloading infrastructure exceed the cost benefits of shipping smaller volumes by rail. Environmental permitting of rail loading and unloading facilities may also require substantial time and uncertainty related to implementation of this mode of transportation for shorter compliance schedules.

Therefore, for sites having relatively small volumes of CCR impacts and short impoundment closure schedules trucking is likely to be the more feasible mode of transportation. Impacts from trucking include impacts on local traffic, localized roadway degradation and effects to adjacent environmental receptors from traffic noise, emissions and vibration during the construction phase. By comparison, impoundments that are closed-by-removal that have large volumes of CCR may use either trucking or rail operations. Trucking over prolonged periods for such sites may be expected to result in impacts that are pronounced and more widespread, whereas removal by rail may be a less impactful and more cost effective alternative relative to trucking.

3.17 Visual Resources

3.17.1 Affected Environment

This assessment provides a review and classification of the visual attributes of existing scenery, along with the anticipated attributes resulting from the proposed action. The classification criteria used in this analysis are adapted from a scenic management system developed by the U.S. Forest Service (USFS) and integrated with planning methods used by TVA. The classification process is also based on fundamental methodology and descriptions adapted from Landscape Aesthetics, A Handbook for Scenery Management, Agriculture Handbook Number 701 (USFS 1995).

The visual landscape of an area is formed by physical, biological and man-made features that combine to influence both landscape identifiability and uniqueness. Scenic resources within a landscape are evaluated based on a number of factors that include scenic attractiveness, integrity and visibility. Scenic attractiveness is a measure of scenic quality based on human perceptions of intrinsic beauty as expressed in the forms, colors, textures and visual composition of each landscape. Scenic integrity is a measure of scenic importance based on the degree of visual unity and wholeness of the natural landscape character. The varied combinations of natural features and human alterations both shape landscape character and help define their scenic importance. The subjective perceptions of a landscape's aesthetic quality and sense of place is dependent on where and how it is viewed.

Scenic visibility of a landscape may be described in terms of three distance contexts: (1) foreground, (2) middleground and (3) background. In the foreground, an area within 0.5 mi of the observer, individual details of specific objects are important and easily distinguished. In the middleground, from 0.5 to 4 mi from the observer, object characteristics are distinguishable but their details are weak and tend to merge into larger patterns. In the distant part of the landscape, the background, details and colors of objects are not normally discernible unless they are especially large, standing alone, or have a substantial color contrast. In this assessment, the background is measured as 4 to 10 mi from the observer. Visual and aesthetic impacts associated with a particular action may occur as a result of the introduction of a feature that is not consistent with the existing viewshed. Consequently, the character of an existing site is an important factor in evaluating potential visual impacts.

For this analysis, the affected environment is considered to include the project area within a TVA CCR facility, which encompasses both permanent and temporary impact areas, any off-site borrow areas, as well as the physical and natural features of the landscape. Any part of the project area located within the TVA facility would be located on previously disturbed lands and within existing industrial infrastructure. Principal features in the foreground include plant structures such as the powerhouse, coal handling system, emissions stacks, switch yard and major transmission corridors. Most of the TVA facilities have limited amounts of any vegetation, although there may be some small patches of grassed areas and/or small trees within the facility grounds. Therefore, scenic attractiveness of the affected environment is considered to be minimal to common, whereas the scenic integrity is considered to be low.

Since fossil fuel facilities are located in mostly remote areas, groups that would likely have direct views of the project area include authorized employees, contactors and visitors to the plant site near the project area. Views of the project area are generally restricted to the foreground (i.e., within a half mile) in all directions, however that may be buffered by nearby vegetation and the local topography.

3.17.2 Environmental Consequences

The potential impacts to the visual environment from a given action are assessed by evaluating the potential for changes in the scenic value class ratings based upon landscape scenic attractiveness, integrity and visibility. Sensitivity of viewing points available to the general public, their viewing distances and visibility of the proposed action are also considered during the analysis. These measures help identify changes in visual character based on commonly held perceptions of landscape beauty and the aesthetic sense of place. The extent and magnitude of visual changes that could result from the proposed action were evaluated based on the process and criteria outlined in the scenic management system.

3.17.2.1 Alternative A – No Action

Under Alternative A, TVA will not close ash impoundments at any of the coal fired plants, resulting in no changes to the existing environment. The landscape character and integrity would remain in its current state; therefore, and there would be no new impacts to aesthetics and visual resources.

3.17.2.2 Alternative B – Closure-in-Place

Under Alternative B, the ash impoundments will be closed in place and will be filled/graded and covered using borrow material from a previously permitted site. During the construction phase, there would be slight visual discord from the existing conditions due to an increase in personnel and equipment in the area. Visual impacts from additional vehicular traffic associated with the transport of borrow materials and construction-related traffic to the work site are expected to be insignificant as the roads in the vicinity of plants are already predominately used for industrial activity. This small increase in visual discord would be temporary and only last until all activities have been completed by TVA.

Permanent impacts would include minor discernible alterations that would be viewed in the foreground of plant operations. In the foreground, the closure of the ash impoundment and cover with natural vegetation may enhance the landscape character compared to the current condition. In more distant views, the closure of the impoundment would likely merge with the overall industrial components of the facility. The proposed activity would have minimal public visibility and would primarily be seen by employees and visitors to the TVA facility. Therefore, the closed impoundment would generally be absorbed by existing TVA plant components and would become visually subordinate to the overall landscape character associated with the plant site.

Overall, the proposed action is not expected to be discernible from the existing scenery nor would it contrast with the overall landscape. There may be some minor visual discord during the construction and subsequent post-construction maintenance period due to an increase in personnel and equipment and the use of laydown and materials storage areas. These minor visual obtrusions would be temporary until all areas have been restored using standard construction and restoration BMPs. Based upon the improved visual characteristics of a vegetated closure system under this alternative, the scenic attractiveness and scenic quality of the project area may be expected to improve to some degree relative to the existing condition. Therefore, visual impacts resulting from implementation of Alternative B would be minor and beneficial in the long term.

3.17.2.3 Alternative C – Closure-by-Removal

Construction phase visual impacts associated with closure activities under Alternative C would be similar to that identified under Alternative B. As with Alternative B, construction activities associated with impoundment closure and the transport of CCR to an off-site landfill could indirectly impact the landscape character along the haul route. For sites having relatively small volumes of CCR impacts are expected to result in a small and temporary increase in visual discord. By comparison, for sites requiring the removal of large volumes of CCR impacts to the visual environment from trucking would be more long lasting and pronounced. Following construction however, based upon the improved visual characteristics of a vegetated former impoundment under this alternative, the scenic attractiveness and scenic quality of the project area may be expected to improve to some degree relative to both the existing condition and Alternative B. Overall, visual impacts resulting from implementation of Alternative B would be minor and beneficial in the long term.

3.18 Cultural and Historic Resources

3.18.1 Affected Environment

3.18.1.1 Regulatory Framework for Cultural Resources

Cultural resources or historic properties include prehistoric and historic archaeological sites, districts, buildings, structures and objects, as well as locations of important historic events. Federal agencies, including TVA, are required by the National Historic Preservation Act (NHPA) (16 USC 470) and by NEPA to consider the possible effects of their undertakings on historic properties. Undertaking means any project, activity, or program, and any of its elements, which have the potential to have an effect on a historic property and that is under the direct or indirect jurisdiction of a federal agency or is licensed or assisted by a federal agency. An agency may fulfill its statutory obligations under NEPA by following the process outlined in the regulations implementing Section 106 of NHPA at 36 CFR Part 800. Additional cultural resource laws that protect historic resources include the Archaeological and Historic Preservation Act (16 USC 469-469c), Archaeological Resources Protection Act

(16 USC. 470aa-470mm) and the Native American Graves Protection and Repatriation Act 925 USC. 3001-3013).

Section 106 of the NHPA requires that federal agencies consider the potential effects of their actions on historic properties and to allow the Advisory Council on Historic Preservation an opportunity to comment on the action. Section 106 involves four steps: (1) initiate the process; (2) identify historic properties; (3) assess adverse effects; and (4) resolve adverse effects. This process is carried out in consultation with the State Historic Preservation Officer (SHPO) of the state where the undertaking takes place and other interested consulting parties, including federally recognized Indian tribes.

Cultural resources are considered historic properties if they are listed or eligible for listing in the National Register of Historic Places (NRHP). The NRHP eligibility of a resource is based on the Secretary of the Interior's criteria for evaluation (36 CFR 60.4), which state that significant cultural resources possess integrity of location, design, setting, materials, workmanship, feeling, association and

1. Are associated with events that have made a significant contribution to the broad patterns of our history; or
2. Are associated with the lives of persons significant in our past; or
3. Embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic value, or
4. Have yielded, or may yield, information (data) important in prehistory or history.

A project may have effects on a historic property that are not adverse, if those effects do not diminish the qualities of the property that identify it as eligible for listing on the National Register. However, if the agency determines (in consultation) that the undertaking's effect on a historic property within the area of potential effect (APE) would diminish any of the qualities that make the property eligible for the NRHP (based on the criteria for evaluation at 36 CFR Part 60.4), the effect is said to be adverse. Examples of adverse effects would be ground disturbing activity in an archaeological site, or erecting structures within the viewshed of a historic building in such a way as to diminish the structure's integrity of feeling or setting.

Agencies must resolve the adverse effects of their undertakings on historic properties. Resolution may consist of avoidance (such as choosing a project alternative that does not result in adverse effects), minimization (such as redesign to lessen the effects), or mitigation. Adverse effects to archaeological sites are typically mitigated by means of excavation to recover the important scientific information contained within the site. Mitigation of adverse effects to historic structures sometimes involves thorough documentation of the structure by compiling historic records, studies and photographs. Agencies are required to consult with SHPOs, tribes and others throughout the Section 106 process and to document adverse effects to historic properties resulting from agency undertakings.

3.18.1.2 Archaeological Resources

3.18.1.2.1 Background

The earliest known human occupation on TVA owned lands occurred during the Paleoindian period. Artifacts typically associated with this period include lanceolate fluted and unfluted basally ground projectile points and later, the Dalton projectile point and adze. The Archaic Period, which immediately followed the Paleoindian period, is divided into the Early (8000-6000 BC), Middle (6000-3000 BC) and Late (3000-1000 BC) subperiods.

The Early Archaic is characterized by a shift from the nomadic bands of the Paleoindian period to a more sedentary social structure with an increased reliance on wild plant foods, small game and aquatic resources (Chapman 1985, Steponaitis 1986). Typical lithic technology consists of Kirk, Big Sandy, LeCroy, during the Early Archaic and Kirk, Morrow Mountain, White Springs, Benton and Stanley cluster projectile points/knives (PPKs) during the Middle Archaic period. The Late Archaic is characterized by an increase in the number and size of sites with diagnostic stone tools that included the Savannah River, Appalachian Stemmed and Iddins PPKs, steatite bowls and grooved axes (Chapman 1985).

In the southeast, the Woodland period is divided into three subperiods: Early (1000 BC-AD 100), Middle (AD 100-600) and Late (AD 600-900) (Steponaitis 1986). The bow and arrow were introduced during the Woodland period, and extensive trade networks were established. The Early and Middle Woodland period is characterized by large base camps in major river valleys with an increase in the reliance on cultivated plants. The Late Woodland period witnessed the continued reliance on domesticated plants, particularly maize, while hunting small game and gathering wild plant foods was still necessary. Increased ceremonialism and religious activity are noted in the construction of conical burial mounds, as well as an increase in the stratification of the social structure (Steponaitis 1986).

The Mississippian period, which is divided into Early (AD 900-1000), Middle (AD 1000-1300) and Late (AD 1300-1600) subperiods, is characterized by major changes in the social structure, subsistence patterns and settlement patterns of the prehistoric people. Large permanent settlements ruled by elite chief and a strong reliance on maize agriculture are typical of the Mississippian period (Bense 1994).

The historic period began with the arrival of de Soto in the southeast. Europeans soon migrated into the southeast encountering the Cherokee in North Carolina, Kentucky, Alabama and Georgia and the Chickasaw in western Tennessee and northern Mississippi. During the 17^{th} and 18^{th} centuries. Native American communities in the southeast had to deal with several European powers including France, Spain and Britain. During this time period, there were constant struggles between the English, French and Spanish, which had a long-term deleterious effect on the Chickasaw and other local Native American tribes. During the American Revolution, the Chickasaw fought on the side of the British, with the Chickasaw Nation becoming the last British stronghold (Gibson 1976). Following the American Revolution, cultural developments in the southeast loosely followed geographical areas.

Archaeological resources are identified through Phase I archaeological surveys conducted for compliance with Section 106. Numerous surveys have been conducted along reservoir shorelines, within reservoirs and on power plant reservations. Some TVA transmission line corridors and roadways have also been surveyed. Outside of TVA reservoirs and plant reservations, little is known about the presence or density of archaeological resources in these areas. Archaeological surveys outside of coal-fired plants vary state by state with most surveys conducted on a project-by-project basis.

3.18.1.2.2 Previously Identified Sites at TVA Coal-Fired Power Plants

Archaeological sites can occur throughout the TVA-owned lands in a variety of environmental contexts. Archaeological sites are rarely found in areas of extreme slope, wet areas and areas that have been heavily disturbed by modern construction activities. Table 3-15 provides a summary of previously recorded NRHP-eligible sites at TVA coal-fired power plants.

Within the boundaries of TVA's coal-fired power plant sites, ash impoundments are typically located near the coal-fired plant and in or near floodplains. Laydown areas will be located in the vicinity of the impoundments being closed. Because ash impoundments and laydown areas are located on heavily disturbed industrial lands where construction required surface grading and the excavation, there is a very low potential for significant cultural resources to be present within the ash impoundment footprints or proposed laydown areas.

3.18.1.3 Historic Resources

Historic architectural resources are standing structures (e.g., houses, barns, dams, power plants) that are usually at least 50 years of age and are considered eligible for listing on NRHP as defined by the Secretary of the Interior criteria for evaluation (36 CFR 60.4). Approximately 5,000 structures, buildings, power plants and infrastructure have been identified and recorded on TVA-owned lands. TVA, in consultation with the various state SHPOs, have evaluated individual fossil plants for their NRHP eligibility (see Table 3-15). TVA, in consultation with the Tennessee SHPO, has determined that the ALF, CUF, GAF, KIF and PAF are not eligible for listing in the NRHP but JSF is potentially eligible. SHF in Kentucky and WCF in Alabama have been recommended as potentially eligible for listing in the NRHP.

Table 3-15. Summary of Previously Identified Cultural Resources at TVA Coal-Fired Plants

Plant Name	Location	NRHP Eligibility of Coal-Fired Plant	Number of NRHP-Eligible Archaeological Sites	Impoundments Considered Eligible for NRHP
ALF	TN	No	0	None
BRF	TN	No	4	None
COF	AL	No		None
CUF	TN	No	4	None
GAF	TN	No	1	None
JSF	KY	Potentially Eligible	4	None
JOF	TN	No	1	None
KIF	TN	No		None
PAF	KY	No		None
SHF	KY	Potentially Eligible	17	None
WCF	AK	Eligible	8	None

3.18.2 Environmental Consequences

3.18.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, TVA will not close ash impoundments at any of the coal-fired plants and therefore, no closure construction activities would be undertaken. No direct, indirect, or cumulative impacts to cultural resources would occur under Alternative A.

3.18.2.2 Alternative B – Closure-in-Place

For Alternative B, the APE will be the existing ash impoundments and laydown areas. The ash impoundment themselves have not been considered individually eligible for listing on the NRHP as less than 50 years in age or as contributing elements for those plants considered eligible for listing on the NRHP. The laydown areas have been identified as areas previously surveyed for cultural resources and/or previously disturbed from other activities. If a laydown area has not been previously surveyed or determined disturbed in a manner to preclude the potential for cultural resources, TVA will survey the laydown parcel. If an archaeological site is identified, TVA will select a different laydown area. TVA will use existing borrow areas and haul roads that have been previously surveyed and permitted where feasible. Areas that would be used for temporary laydown areas will be used for temporary parking and equipment and material storage.

A potential exists for indirect impacts associated with construction activities related to closure and the transport of borrow materials from an off-site location to the impoundment area. Borrow will be obtained from an existing authorized site, but noise and vibration associated with the transport of borrow material could have an indirect impact to historic resources in the vicinity of the construction site or adjacent to the transportation route. It is expected, however, that construction-related traffic from more distant borrow sites (i.e., 10 to 30 mi) will utilize interstate or major arterial roadways where possible to minimize impacts. Therefore, any indirect impacts would be temporary and limited to the construction period. Indirect impacts would be minor and would not impair or have an adverse effect on historic properties.

Therefore, TVA anticipates that no historic properties would be affected by closure activities associated with Alternative B. Should undisturbed lands be required for laydown areas, TVA will comply with Section 106 requirements prior to closure activities affecting these areas.

3.18.2.3 Alternative C – Closure-by-Removal

Similar to Alternative B, no direct impact to historic properties will occur from Alternative C. No historic properties have been identified at the ash impoundment locations.

All CCR removed from the ash impoundment will be transported to a permitted landfill (either on-site or off-site). Indirect impacts from transporting CCR to a permitted landfill would have similar impacts as those discussed under Alternative B, but likely be for longer durations. Indirect impacts would be minor and would not impair or have an adverse effect on historic properties. As volumes of CCR transported increase, noise and vibration impacts could occur for longer periods of time and could have greater effects.

TVA finds that no historic properties would be affected by closure activities associated with Alternative C. Should undisturbed lands be required for additional laydown areas, TVA will comply with Section 106 requirements prior to closure activities affecting these areas.

3.19 Noise

3.19.1 Affected Environment

Noise is unwanted or unwelcome sound usually caused by human activity and added to the natural acoustic setting of a locale. It is further defined as sound that disrupts normal activities diminishes the quality of the environment. Community response to noise is dependent on the intensity of the sound source, its duration, the proximity of noise-sensitive land uses and the time of day the noise occurs (i.e., higher sensitivities would be expected during the quieter overnight periods).

Sound is measured in units of decibels (dB) on a logarithmic scale. The “pitch” (high or low) of the sound is a description of frequency, which is measured in Hertz (Hz). Most common environmental sounds are a composite of sound energy at various frequencies. A normal human ear can usually detect sounds that fall within the frequencies from 20 Hz to 20,000 Hz. However, humans are most sensitive to frequencies between 500 Hz to 4,000 Hz.

Given that the human ear cannot perceive all pitches or frequencies in the sound range, sound level measurements are typically weighted to correspond to the limits of human hearing. This adjusted unit of measure is known as the A-weighted decibel (dBA). A noise change of 3 dBA or less are not normally detectable by the average human ear. An increase of 5 dBA is generally readily noticeable by anyone, and a 10 dBA increase is usually felt to be "twice as loud" as before.

To account for sound fluctuations, environmental noise is commonly described in terms of the equivalent sound level or Leq. The Leq value, expressed in dBA, is the energy-averaged, A-weighted sound level for the time period of interest. The day-night sound level (Ldn), is the 24-hr equivalent sound level, which incorporates a 10-dBA correction penalty for the hours between 10 p.m. and 7 a.m., to account for the increased sensitivity of people to sounds that occur at night.

Common indoor and outdoor sound levels are listed in Table 3-16.

3.19.1.1 Noise Regulations

The Noise Control Act of 1972, along with its subsequent amendments (Quiet Communities Act of 1978, USC. 42 4901-4918), delegates authority to the states to regulate environmental noise and directs government agencies to comply with local community noise statutes and regulations. Many local noise ordinances are qualitative, such as prohibiting excessive noise or noise that results in a public nuisance. Because of the subjective nature of such ordinances, they are often difficult to enforce. Only one of the counties in which TVA fossil-fuel power plants are located (Anderson County, Tennessee) has established quantitative sound-level regulations specifying environmental sound level limits based on the land use of the property receiving the noise.

There is considerable variation in individual response to noise. Noise that one person would consider mildly annoying, another person may consider highly annoying or not annoying at all. The EPA noise guideline recommends an L_{dn} of 55 dBA, which is sufficient to protect the public from the effect of broadband environmental noise in typical outdoor and residential areas. These levels are not regulatory goals but are “intentionally conservative to protect the most sensitive portion of the American population” with “an additional margin of safety" (EPA 1974). The U.S. Department of Housing and Urban Development (HUD) considers an Ldn of 65 dBA or less to be compatible with residential areas (HUD 1985).

Table 3-16. Common Indoor and Outdoor Noise Levels

Common Outdoor Noises	Sound Pressure Levels (dB)	Common Indoor Noises
	110	Rock Band (15 ft)
Jet Fly-Over (1000 ft)		
	100	
Gas Lawn Mower (3 ft)		
	90	Food Blender (3 ft)
Diesel Truck (50 ft)		
	80	Garbage Disposal (3 ft)
Gas Lawn Mower (100 ft)	70	
		Vacuum Cleaner (10 ft)
		Normal Speech (3 ft)
Heavy Traffic (300 ft)	60	
	50	Dishwasher Next Room
Typical Urban Daytime		
	40	
Urban Nighttime		Library
	30	Bedroom at Night
Rural Nighttime		
	20	Whisper
	10	
	0	Threshold of Hearing

Source: Arizona DOT, 2008

3.19.1.2 Background Noise Levels

Noise levels continuously vary with location and time. In general, noise levels are high around major transportation corridors along highways, railways, airports, industrial facilities and construction activities. Sound from a source spreads out as it travels from the source, and the sound pressure level diminishes with distance. In addition to distance attenuation, the air absorbs sound energy; atmospheric effects (wind, temperature, precipitation) and terrain/vegetation effects also influence sound propagation and attenuation over distance from the source. An individual's sound exposure is determined by measurement of the noise that the individual experiences over a specified time interval.

Community noise refers to outdoor noise near a community. A continuous source of noise is rare for long periods and is typically not a characteristic of community noise. Typical background day/night noise levels for rural areas range between 35 and 50 dB whereas higher-density residential and urban areas background noise levels range from 43 dB to 72 dB (EPA 1974). Background noise levels greater than 65 dBA can interfere with normal conversation, watching television, using a telephone, listening to the radio and sleeping.

3.19.1.3 Sources of Noise

Coal-fired power plant operations and ancillary activities are expected to be the primary source of background noise at most operational TVA facilities. Ambient noise at those coal-fired power plants that are no longer operational would be characterized by adjacent roadway traffic and general environmental background noise which would be relatively low as most coal-fired power plants are located in rural settings. Noise sources common to activities evaluated in this EIS include noise from operating industrial and utility facilities, transportation noise and construction noise.

Operations at operating coal-fired power plants generate varying amounts of environmental noise and can include noise generating activities associated with barge operations, coal unloading activities and heavy equipment operations associated with coal pile management, truck operations and occasional rail operations. Existing noise emission levels associated with these activities typically range from 59 to 87 dBA (TVA 2014).

Transportation noise related to activities evaluated in the EIS primarily includes noise from highway traffic. However some of TVAs coal-fired power plants support rail traffic which would also generate noise. Three primary factors influence highway noise generation; traffic volume, traffic speed and vehicle type. Generally, heavier traffic volumes, higher speeds and greater numbers of trucks increase the loudness of highway traffic noise. Other factors that affect the loudness of traffic noise include a change in engine speed and power, such as at traffic lights, hills and intersecting roads and pavement type. Highway traffic noise is not usually a serious problem for people who live more than 500 ft from heavily traveled freeways or more than 100 to 200 ft from lightly traveled roads. (FHWA 2011). Due to the nature of the decibel scale and the attenuating effects of noise with distance, a doubling of traffic will result in a 3 dBA increase in noise levels, which in and of itself would not normally be a perceivable noise increase. Railway noise depends primarily on the speed of the train but variations are present depending upon the type of engine, wagons and rails (Berglund and Lindvall 1995).

The level of construction noise is dependent upon the nature and duration of the project. Construction activities for most large-scale projects would be expected to result in increased noise levels as a result of the operation of construction equipment on-site and the movement of construction-related vehicles (i.e., worker trips, and material and equipment trips) on the surrounding roadways. Noise levels associated with construction activities will increase ambient noise levels adjacent to the construction site and along roadways used by construction-related vehicles. Construction noise is generally temporary and intermittent in nature as it generally only occurs on weekdays during daylight hours which minimizes the impact to sensitive receptors.

3.19.2 Environmental Consequences

3.19.2.1 Alternative A – No Action

Under the No Action Alternative TVA will not close ash impoundments at any of the coal-fired plants. Although no additional CCR will be managed in the impoundments, TVA will continue to perform care and maintenance activities as needed that may include inspec-tions, cutting and maintaining vegetation on interior and exterior slopes, repair of eroded and rutted areas and repair/regrade animal paths and burrows and seeding and mulching bare areas. Therefore, there would be no change in the existing noise environment.

3.19.2.2 Alternative B – Closure-in-Place

Under Alternative B, CCR impoundments will be closed in place. Noise impacts would be associated with on-site closure activities and transport of borrow materials and other construction-related traffic to and from the work site. Closure activities would be temporary and most of the work would occur during the day on weekdays. However, construction activities could occur at night or weekends if necessary.

Heavy construction equipment used for closure activities will include (but may not be limited to) stationary equipment (generators and compressors), excavators, compactors, dump trucks graders, loaders, compactors, haul trucks, bulldozer, water trucks, cranes, forklifts, utility vehicles and boats. Noise from heavy equipment is primarily contained within the construction site. As illustrated by Table 3-17, typical noise levels from construction equipment used for closure are expected to be 85 dBA or less when measured at 50 ft. These types of noise levels would diminish with distance from the project area at a rate of approximately 6 dBA per each doubling of distance and therefore would be expected to attenuate to the recommended EPA noise guideline of 55 dBA at 1,500 ft. However, this distance would be shorter in the field as objects and topography would cause further noise attenuation. The ash impoundments at TVA's coal-fired power plants are generally located in remote areas currently used for industrial purposes and therefore most construction noise levels at the closest noise-sensitive receptor (i.e. residences, parks and recreation areas and schools) would be attenuated over distance and would be similar to noise from plant operations. For nonoperational plants, the existing noise levels are lower and therefore, construction-related noise would be a primary source of noise. However, due to the temporary and intermittent nature of construction and the attenuating effects of noise levels over distance, construction phase impacts to sensitive noise receptors are expected to be minimal. Examples of sensitive noise receptors include residences, parkland and churches.

Table 3-17. Typical Construction Equipment Noise Levels

Equipment	Noise Level (dBA) at 50 ft
Dump Truck	84
Bulldozer	85
Scraper	85
Grader	85
Excavator	85
Compactor	80
Concrete Truck	85
Boring-Jack Power Unit	80
Backhoe (trench)	80
Flatbed Truck	84
Crane (mobile)	85
Generator	82
Air Compressor	80
Pneumatic Tools	85
Welder/Torch	73

Source: FHWA 201

Indirect noise impacts would be associated with the transportation related activities. Depending on the particular size and closure requirements at each site, varying amounts of borrow materials may be required to construct an approved cover system. For sites requiring little borrow material, the duration of transport activities and associated noise impact would be relatively short, whereas for larger sites, borrow transport activities may extend for longer periods of time. Noise impacts from the transport of borrow material are therefore, subject to site specific analysis and may range from short term and minor to long term and substantial.

Transportation related effects may also occur in conjunction with construction-related traffic (the construction workforce and the shipment of goods and services) to the work site. As identified in Section 3.16, construction-related traffic will utilize interstate highways or major arterial roadways as much as possible and likely would not have a noticeable increase on traffic volume and consequently traffic noise in the vicinity of those major roadways However, construction-related traffic and transport of borrow material may result in an increase in intermittent noise at residences or other sensitive receptors located along any local roads that may be utilized during the construction period. For borrow sites at greater distances from the plant site, trucks are expected to use larger arterial roadways for much of the travel to and from the borrow site. Noise impacts from the additional transport of borrow along these arterial roadways is expected to be minor relative to existing baseline traffic-related noise. However, for receptors along the local roadway system serving each plant, noise related effects may be more pronounced during the construction period.

3.19.2.3 Alternative C – Closure-by-Removal

Direct noise impacts associated with on-site closure activities would be the same as identified under Alternative B and due to the temporary and intermittent nature of construction, and the attenuating effects noise levels over distance, construction phase impacts to sensitive noise receptors are expected to be negligible.

As with Alternative B, construction related traffic associated with impoundment closure and the transport of CCR to an off-site landfill and the transport of borrow material could indirectly impact noise sensitive receptors located proximate to area roadways. Indirect impacts associated with the transport of borrow material would be similar, as those described for Alternative B.

Noise emissions associated with the transport of CCR materials differs from Alternative B. Depending on the volume of CCR materials to be removed, larger amounts of equipment (especially haul trucks) would be required and the associated work force needed to operate this equipment would be larger. For sites having a lower volume of CCR (<500,000 yd^3) the combined use of trucks hauling off CCR from the site and hauling of borrow material to the site could total over 175 loads per day under the Closure-by-Removal alternative. Under this scenario there could be a truck passing in front of a residence or other noise sensitive receptor every 1.5 minutes. While the intensity of the truck noise may be lower at receptors more distant from a roadway, frequent truck trips transporting CCR materials would increase the magnitude of the noise impact.

For impoundments with extremely large volumes of CCR, this impact may be long term and more intense. For example, strategies to shorten the duration of the removal effort may be accomplished by increasing the number of trucks. However, this would also increase the noise intensity due to the higher volume and increase the frequency of the disturbance.

Under this alternative, noise impact magnitude and significance would therefore, vary and depend upon volume and duration of CCR removal.

Therefore, noise impacts resulting from the implementation of Alternative C are related to the transportation of CCR off-site and are dependent upon both CCR volume to be removed and schedule for impoundment closure. For sites having relatively small volumes of CCR impacts are expected to be minor and localized. By comparison, for sites requiring the removal of large volumes of CCR impacts from traffic related noise may be expected to be pronounced and more widespread.

3.20 Solid Waste and Hazardous Waste and Hazardous Materials

3.20.1 Affected Environment

Solid waste consists of a broad range of materials that include refuse, sanitary wastes, contaminated environmental media, scrap metals, nonhazardous wastewater treatment plant sludge, nonhazardous air pollution control wastes, various nonhazardous industrial waste, and other materials (solid, liquid, or contained gaseous substances).

Hazardous materials are defined as any substance or material that has been determined to be capable of posing an unreasonable risk to health, safety and property. Hazardous material includes hazardous substances and hazardous waste. Under the RCRA hazardous waste is listed, or meets the characteristics described in 40 CFR Part 261, including ignitability, corrosivity, reactivity, or toxicity.

Hazardous materials and management of these materials are regulated under a variety of federal laws including the Occupational Safety and Health Administration (OSHA) standards, Emergency Planning and Community Right to Know Act and RCRA subtitle C. TVA adheres to these requirements either because they legally apply to its activities or as a matter of policy.

With the issuance of its CCR Rule on December 19, 2014, EPA decided to continue to regulate CCRs as solid wastes. This includes fly ash, bottom ash and FGD solids (i.e., gypsum and calcium sulfite). Coal-fired plants remove these solid wastes through both wet and dry disposal methods. Dry disposal practices typically involve transferring the combustion wastes to a storage silo or outdoor storage pile to either be hauled to a landfill or, depending on the particular residual, sent off-site where it may be used to create beneficial by-products such as drywall or cement. In wet handling systems, bottom ash and fly ash is transported from the boiler and particulate removal units and is typically disposed of in surface impoundments. The properties of these wastes vary with the type of coal plant, the chemical composition of the coal and other factors (TVA, 2015). Although CCRs are not considered a hazardous waste, they can contain hazardous substances in varying amounts.

TVA is required to comply with EPA's CCR Rule, which provides specific deadlines for compliance. EPA issued minimum national criteria, including requirements for composite liners, groundwater monitoring, structural stability requirements, corrective action and closure/post-closure care. EPA determined that compliance with these requirements would "not pose a reasonable probability of adverse effects on health or the environment." 89 Federal Register 21468 (40 C.F.R. 257.50(a)). Saying this differently, compliance with the CCR Rule is expected to adequately protect human health and the environment.

During 2013, TVA produced approximately 4.2 million tons of CCRs with approximately half being synthetic gypsum and 33 percent being fly ash (Table 3-18.). Of the 4.2 million tons, 0.9 million tons, or 21 percent, were utilized or marketed, which is a decrease the from the 2.8 million ton annual average for 2006-2008, mostly due to reduced demand resulting from the recent recession. In 2014, the beneficial reuse rate of CCRs increased to 29 percent. The main beneficial uses of coal combustion solid wastes are in the manufacture of wallboard, roofing, cement, concrete and other products.

Table 3-18. Coal Combustion Residuals Generated by TVA from 2010-2013

	Production (tons)		Utilization (Percent)	
CCR Material[1]	**2010-2012 Average**	**2013**	**2010-2012 Average**	**2013**
Fly Ash	1,798,352	1,389,857	18.8%	30.1%
Bottom Ash	356,975	288,543	0.2%	0.0%
Boiler Slag	482,986	409,385	63.9%	71.0%
Synthetic Gypsum	2,406,276	2,150,356	23.3%	22.6%
Total	5, 044,589	4,238,141	17.7%	20.6%

Source: TVA 2015

[1] Does not include Char and Spent Bed Material that is no longer produced at TVA facilities.

The CCRs that are not sold for reuse are currently managed in landfills and impoundments at or near coal plant sites.

A variety of hazardous materials are used as part of daily operations at TVAs coal-fired power plants. A byproduct of the use of hazardous materials is the generation of hazardous wastes. Consequently, most TVA coal-fired plants are classified as small quantity generators of hazardous waste, generating between 100 and 1,000 kilograms of hazardous waste per month. The proper management of these materials/wastes is performed in accordance with established procedures and applicable regulations.

3.20.2 Environmental Consequences

3.20.2.1 Alternative A – No Action

Under Alternative A, TVA will not close ash impoundments at any of the coal-fired power plants. However, TVA is in the process of converting all wet ash and gypsum storage facilities, to dry storage and disposal facilities and does not plan to use ash impoundments for management of CCRs in the future. Solid and hazardous wastes generated at TVA coal-fired power plants will continue to be managed in accordance with established procedures and applicable regulations. Therefore, no impacts to solid waste and hazardous waste generation are anticipated.

3.20.2.2 Alternative B – Closure-in-Place

The only solid and hazardous wastes generated under this alternative would be from closure activities. Table 3-19 identifies representative solid and hazardous wastes that could be generated as a result of closure activities under this alternative.

Table 3-19. Representative Hazardous and Solid Wastes Generated During Construction

Waste	Origin	Composition or Characteristic	Disposal Method
Solid Waste			
Scrap wood, steel, glass, plastic, paper	Construction activities	Normal refuse	Recycle and/or dispose of in a Class I landfill
Land clearing wastes	Construction activities	Solids	Dispose of in a Class III or IV landfill
Waste oil filters	Construction equipment and vehicles	Solids	Recycle at a permitted TSDF
Oil fuel and solvent rags	Cleanup of small spills, cleaning and degreasing operations	Hydrocarbons	Dispose at a Class I landfill as special wastes
Non-hazardous solvents, paint, adhesives	Construction activities, Equipment cleaning	Solvents paints, adhesives that are not characteristic or listed hazardous waste	Dispose at a Class I landfill as special waste
Sanitary waste	Portable toilet holding tanks	Solids and liquids	Remove by contracted sanitary service
Hazardous Waste			
Used and waste lubricating and hydraulic oils	Construction vehicles and equipment	Hydrocarbons	Recycle at a permitted treatment, storage and disposal facility (TSDF)
Oily rags, oily sorbent	Cleanup of small spills	Hydrocarbons	Dispose at a permitted TSDF
Fuels, absorbents and soils contaminated by gasoline or diesel	Construction equipment	Ignitable, benzene, other hydrocarbons	Dispose at a permitted TSDF or recycle
Solvents, paint, adhesives	Construction activities, equipment cleaning	Ignitable solvents; solvents paints, adhesives containing constituents identified as characteristic hazardous waste (40 CFR 261 Subpart C); Solvents listed under 40 CFR 261 Subpart D	Recycle or dispose at a permitted TSDF
Solvent and fuel contaminated rags	Construction activities, equipment cleaning	See above	Recycle or dispose at a permitted TSDF
Miscellaneous acids and alkalis	Construction activities	Corrosive hazardous wastes	Dispose at a permitted TSDF
Spent lead acid batteries	Construction machinery	Lead, sulfuric acid	Manage as universal wastes
Spent lithium and Ni/Cd batteries	Equipment construction machinery	Heavy metals	Manage as universal waste
Fluorescent, mercury vapor and high intensity (sodium vapor) lamps	Lighting equipment	Mercury and other metals	Recycle or dispose of-site as universal waste
Contaminated environmental media	Site preparation	Varies	Dispose at permitted TSDF or Class I landfill

The primary waste streams resulting from construction would be solid nonhazardous waste. However, some nonhazardous liquid waste would also be generated. During construction, the primary solid nonhazardous wastes generated would be refuse from the contractor personnel, a small volume of construction debris (liner scraps, piping removed, etc.) and soils as briefly summarized below:

- Construction debris consisting primarily of liner scraps, piping removed, miscellaneous construction rubble, wastes from packing materials and empty nonhazardous chemical containers during project construction.
- Land clearing wastes would result from grading operations.
- Soils would result from land clearing, grading and excavation.

In addition to these larger nonhazardous waste streams, limited quantities of nonhazardous solvents, paints and adhesives, spill absorbent, oil and solvent contaminated rags, and empty containers would be generated.

Various hazardous wastes, such as fuels, lubricating oils, solvents, paints, adhesives, compressed gases and other hazardous materials could also be produced during construction. Oily wastes generated during servicing of heavy equipment will not be stored on site, but will be managed by off-site vendors who service on-site equipment using appropriate self-contained used oil reservoirs. Appropriate spill prevention, containment and disposal requirements for hazardous wastes would be implemented to protect construction and plant workers, the public and the environment.

TVA would manage all solid waste and hazardous wastes generated from construction activities in accordance with standard procedures for spill prevention and cleanup and waste management protocols in accordance with pertinent federal, state and local requirements.

Therefore, only minimal direct or indirect effects related to solid or hazardous wastes are anticipated from closure activities

3.20.2.3 Alternative C – Closure- by-Removal

Similar to Alternative B, the proposed ash impoundment closure would result in the generation of some construction-related solid and hazardous wastes. With implementation of the standard procedures for spill prevention and cleanup and waste management protocols in accordance with pertinent federal, state and local requirements, only minimal direct or indirect adverse effects related to solid or hazardous wastes are anticipated from closure activities.

In addition, under this closure alternative, TVA will excavate and relocate the CCRs from ash impoundments to either on-site or existing off-site facilities. OSHA requirements for workers engaged in excavation activities will be applied. Transport of CCRs will be managed under the requirements set forth under RCRA subtitle D and in accordance with pertinent state and local requirements and impacts to solid waste and hazardous waste generation are not significant.

3.21 Public Health and Safety

Workplace health and safety regulations are designed to eliminate personal injuries and illnesses from occurring in the workplace. These laws may comprise both federal and state statutes. U.S. Department of Labor, Occupational Safety and Health Act (OSHA) is the main statute protecting the health and safety of workers in the workplaces. OSHA regulations are presented in Title 29 CFR Part 1910 (29 CFR 1919), OSHA Standards. A related statute, 29 CFR 1926, contains health and safety regulations specific to the construction industry. The Tennessee Department of Labor and Workforce Development has adopted federal OSHA standards contained in 29 CFR Parts 1910 and 1926 pursuant to Tennessee Code Annotated Section 50-3-201. Additionally, the federal regulations govern workplace health and safety requirements in private sector workplaces in Alabama since no state law governs workplace safety for public sector employers. The Kentucky Occupational Safety and Health Program, under the statutory authority of Kentucky Revised Statutes Chapter 338 has a state plan approved by the OSHA to protect the health and safety of workers in the workplaces.

3.21.1 Affected Environment

The routine operations and maintenance activities at the existing TVA facilities reflect a safety conscious culture. Activities are performed consistent with OSHA and state standards and requirements and specific TVA guidance. Personnel at TVA facilities are conscientious about health and safety having addressed and managed operations to reduce or eliminate occupational hazards through implementation of safety practices, training and control measures.

TVA has a safety program in place to prevent worker injuries and accidents. The various prevention programs include but are not limited to the following:

- Operations and Maintenance Plans
- Hazard Communication
- Housekeeping
- Project Safety Plans
- Competent Person
- Ground Disturbance
- Lifting Operations
- Energy Isolation (Lockout/Tag out)
- Cutting, Burning, Welding and other “Hot Work”
- Incident Reporting and Investigations
- Personal Protective Equipment
- Hearing Conservation
- Employee Training
- Contractor Evaluation and Acceptance
- Emergency Spill/Release Plans
- Emergency Response Plan

The implementation of proper engineering and equipment design, administrative controls such as employee training and compliance with regulatory requirements related to Health and Safety, help ensure that the risks associated with work at TVA facilities remain low.

Health risks are also associated with emissions and discharges from the facilities as well as accidental spills/releases and there are comprehensive environmental regulatory programs in place to manage and reduce such risks to acceptable levels. Coal-fired power plants are among the most heavily regulated industrial facilities in the country in this regard.

3.21.2 Environmental Consequences

3.21.2.1 Alternative A - No Action Alternative

The operations and maintenance activities at the TVA facilities will continue within the safety conscious culture and activities currently performed in accordance with applicable standards or specific TVA guidance. Facilities will continue to address and manage reduction or elimination of occupational hazards through implementation of safety practices, training and control measures. TVA's safety conscious efforts will continue such that potential impacts on worker and public health and safety would be reduced.

3.21.2.2 Alternative B – Closure-in-Place

Construction activities in support of the ash impoundment Closure-in-Place will be performed consistent with standards as established by OSHA and state requirements. These activities include excavating and backfilling CCR and borrow (fill) material, placement of geomembranes and transportation of borrow material.

Notably, a recent study conducted by EPRI has evaluated the potential impacts of Closure-in-Place and Closure-by-Removal using a hypothetical CCR impoundment in Tennessee. Under a closure scenario similar to Alternative B, EPRI found that the risk of injuries and fatalities would be approximately 50 percent greater for the Closure-by-Removal alternative than the Closure-in-Place alternative (EPRI 2015c).

The risk of impacts of the Closure-in-Place alternative would be temporary and limited to the construction period. During construction, customary industrial safety standards as well as the establishment of appropriate BMPs and job site safety plans would address job safety during the project. This includes the use of personal protective equipment when appropriate; programs for lockout, right-to-know, hearing conservation, heavy equipment operations, excavations, transportation and other activities; the performance of employee safety orientations and regular safety inspections; and the development of a plan of action for the correction of any identified hazards. All these measures would help ensure that job site safety risks are reduced.

Once closed, the TVA ash impoundment areas (all located within TVA plant sites) would be appropriately maintained. Facility health and safety practices would address and manage the reduction or elimination of occupational and public health hazards through implementation of safety practices, training and control measures in accordance with applicable federal, state and local laws and regulations and all applicable permit requirements.

3.21.2.3 Alternative C – Closure-by-Removal

As with Alternative B, construction activities in support of the ash impoundment Alternative C Closure-by-Removal will be performed consistent with standards as established by OSHA and state requirements.

Construction activities associated with impoundment Closure-by-Removal will include the excavation and disposal of CCRs from ash impoundments to either on-site or existing off-site facilities. Deep excavations into ash impoundments under the Closure-by-Removal alternative are particularly dangerous as noted by reports of accidents leading to injury or death in the industry (Mitchell 2015). Additionally, extensive off-site trucking of CCR materials would represent an increased risk to worker safety and safety of the traveling public as a result of higher accident rates (especially on less improved secondary and local roadways).

In the analysis of the closure of the hypothetical CCR impoundment in Tennessee, EPRI also evaluated the potential effects of a closure scenario similar to Alternative C. EPRI found that for both injury and fatality incidents, the negative impacts of excavate and redispose are about two-fold greater than in-place closure (EPRI 2015c). Even greater risks of injury and fatality would occur for sites having especially high volumes of CCR.

Customary industrial safety standards including OSHA requirements for workers engaged in excavation activities would help reduce these risks. In addition, the establishment of appropriate BMPs and job site safety plans would address transportation in describing how job safety will be maintained during the project. These BMPs and site safety plans address the implementation of procedures to ensure that equipment guards, housekeeping and personal protective equipment are in place; the establishment of programs and procedures for lockout, right-to-know, hearing conservation, heavy equipment operations, excavations and other activities; the performance of employee safety orientations and regular safety inspections; and the development of a plan of action for the correction of any identified hazards. All these measures would help ensure that job site safety risks are reduced.

Similar to the closure-in-place alternative, TVA ash impoundment areas (all located within TVA plant sites) will be maintained, and facility health and safety practices would help reduce occupational and public health risks.

Therefore, the risk of adverse impacts to worker and public safety would be reduced. However, because of the volume of material that would be transported (both CCR and borrow material) and the duration of the closure project (years), the risks of impacts under Alternative C is much greater than under Alternative B.

3.22 Unavoidable Adverse Environmental Impacts

Unavoidable adverse impacts are the effects of the proposed action on natural and human resources that would remain after mitigation measures or BMPs have been applied. Mitigation measures and BMPS are typically implemented to reduce a potential impact to a level that would be below the threshold of significance as defined by the CEQ and the courts.

Impacts associated with the closure of impoundments at TVA coal-fired power plants have the potential to cause unavoidable adverse effects to several environmental resources. On the other hand, impoundment closure also would be environmentally beneficial by reducing potential surface and groundwater contamination. The magnitude of adverse impacts and the degree to which they can be successfully avoided, minimized, or mitigated would vary from site to site. However, the impacts from closure under both alternatives would primarily be related to construction activities.

Specifically, activities associated with the use of construction equipment may result in varying amounts of dust, air emissions and noise that may potentially impact both on-site workers and nearby off-site residences and parks. Emissions from on-site construction activities and equipment are minimized through implementation of BMPs including proper maintenance of construction equipment and vehicles. During construction, BMPs to minimize runoff will be implemented but there could still be some uncontrolled runoff that could affect nearby outfalls and water bodies.

The transport of borrow material and CCRs to and from the ash impoundment sites as well as an increase in the construction workforce and construction-related equipment would increase traffic on public roads. This additional construction-related traffic would also increase noise and fugitive dust in areas proximate to these roads. Emissions from construction equipment are minimized through implementation of BMPS including proper maintenance of construction equipment and vehicles.

3.23 Relationship of Short-Term Uses and Long-Term Productivity

NEPA requires a discussion of the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity. This PEIS focuses on the analyses of environmental impacts associated with the closure of ash impoundments at all TVA coal-fired power plants. For the purposes of this section, activities associated with closure of the ash impoundments are considered short-term uses of the environment and the long term is considered to be initiated upon the completion of closure activities. This section includes an evaluation of the extent that the short-term uses preclude any options for future long-term use of the project site.

Closure of ash impoundments would have a negative effect on a limited amount of short-term uses of the environment such as air, noise and transportation resources as described above. Access to the TVA property where ash impoundments are located would be restricted during construction activities. This would primarily impact recreational users such as bank fisherman, birders, etc. In addition, construction activities such as site preparation and noise may displace some wildlife during the construction period. Most environmental impacts during closure activities would be relatively short term and would be addressed by programmatic BMPs and mitigation measures, but the duration of potential impacts would increase substantially depending on the amount of CCR and borrow material that is moved on-site and off-site.

Ash impoundment closure would have a favorable short-term impact to the local economies where TVA coal-fired power plants are located through the creation of construction and support jobs and revenue.

Long-term effects would include the permanent loss of waterfowl and wading bird habitat as ash impoundments are dewatered, and the potential permanent loss of recreational use as a result of implementation safety and security measures which would result in access restrictions to ash impoundments that are closed-in-place. However, other higher quality waterfowl and wading bird habitat is generally located elsewhere in the vicinity of the fossil plants as they are generally located on large rivers or reservoirs.

Ash impoundments that are closed-in-place will remain and safety and security requirements as well as post closure monitoring could limit other future use of these lands. Ash impoundments that are closed-through-removal would not be subject to future restrictions under the CCR Rule and these lands may be available for future industrial or nonindustrial use. However, all of the impoundments are located in areas presently dedicated for industrial uses which would limit future use of these sites.

In the near future, disposal of CCRs at all TVA coal-fired power plants will utilize a dry system. Ash impoundment closure would have a beneficial effect on long-term productivity through the reduction or elimination of potential subsurface discharges of leachate to groundwater that would occur as a result of closure of the ash impoundment.

3.24 Irreversible and Irretrievable Commitments of Resources

A resource commitment is considered irreversible when impacts from its use would limit future use options and the change cannot be reversed, reclaimed, or repaired. Irreversible commitments generally occur to nonrenewable resources such as minerals or cultural resources and to those resources that are renewable only over long time spans, such as soil productivity.

A resource commitment is considered irretrievable when the use or consumption of the resource is neither renewable nor recoverable for use by future generations until reclamation is successfully applied. Irretrievable commitments generally apply to the loss of production, harvest, or natural resources and are not necessarily irreversible.

In relation to ash impoundment closure, resources that construction activities would require, including labor, fossil fuels and construction materials, would be committed for the life of the project. Nonrenewable fossil fuels would be irretrievably lost through the use of gasoline and diesel-powered equipment during construction. In addition, construction materials (such as liners) would be consumed. However, it is unlikely that their limited use in these projects would adversely affect the future availability of these resources generally.

The transfer of borrow material from the borrow site to the ash impoundment could be both an irreversible and irretrievable commitment of resources. The loss of soil (which requires a very long time to generate) would constitute an irreversible and irretrievable resource commitment; however, revegetating the borrow site and ash impoundment would return both sites to productive status. Thus, the loss of vegetation until the areas are successfully revegetated would be an irretrievable commitment, but not irreversible.

The land used for the ash impoundments that are closed-in-place would be irreversibly committed as the CCR material would remain in place for the foreseeable future representing a permanent commitment of the land and precluding future use of the land. However, as these sites would be vegetated they would support some natural resources.

Land used by ash impoundments that are closed through removal is not irreversibly committed because once closure is complete, the land could be returned to other industrial or non-industrial uses at some time in the future.

3.25 Cumulative Effects

The CEQ regulations (40 CFR 1500-1508) implementing the procedural provisions of the NEPA of 1969, as amended (42 USC 4321 et seq.) define cumulative impact as:

> "…the impact on the environment which results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR § 1508.7).

Baseline conditions reflect the impacts of past and present actions. The impact analyses summarized in preceding sections are based on baseline conditions and either explicitly or implicitly consider cumulative impacts.

3.25.1 Geographic Area of Analysis

The appropriate geographic area over which past, present and future actions could reasonably contribute to cumulative effects is variable and dependent on the resource evaluated. Actions related to ash impoundment closure within TVA's system of coal-fired power plants vary with respect to location and timing. However, they are unified under this cumulative effects analysis as "similar" actions. Therefore, for this programmatic level cumulative effects analysis TVA's service area is considered to be the appropriate context for analysis of cumulative effects of TVA ash impoundment closure for most resource areas.

This geographic area includes the Tennessee River Watershed and along the Cumberland, Mississippi, Green and Ohio Rivers (where all the TVA operated coal fired plants are located) as identified in Figure 1-1.

3.25.2 Identification of "Other Actions"

Past, present and reasonably foreseeable future actions that are appropriate for consideration in a cumulative effects analysis are those that which when viewed with the proposed action have cumulatively significant impacts. TVA recognizes that many types of actions by others within the TVA service area have varying levels of impact on environmental resources. Such actions may include state highway maintenance and improvement projects, airport operations and expansions, rail development projects, industrial and mining operations and other actions. Those actions cannot be identified sufficiently to take them into account in TVA's analyses other than in the most broadest sense. For this analysis TVA considered its broader program activities within the service area as being the predominant and appropriate context for analysis against the proposed closure of impoundments across its system of coal-fired power plants.

TVA's operations within the Tennessee Valley form a baseline of actions that influence environmental resources within the service area. Primary operations include those associated with energy, the environmental management and economic development.

3.25.2.1 Energy

TVA operates the nation's largest public power system, including 41 active coal-fired units, six nuclear units, 109 conventional hydroelectric units, four pumped-storage units, 87 simple-cycle combustion turbine units, 11 combined cycle units, five diesel generator units, one digester gas site and 16 solar energy sites. TVA also purchases power from third-party operators under long-term power purchase agreements. TVA's 16,000-mile-long transmission system is one of the largest in North America. For the past 14 years, the system achieved 99.999 percent power reliability. It efficiently delivered more than 161 billion kilowatt-hours of electricity to customers in FY 2014. Research is also ongoing related to emerging technological advances in small modular nuclear reactors (SMRs), grid modernization for transmission and distribution systems, energy utilization technologies and distributed energy resources (TVA 2015b).

3.25.2.2 Environmental Stewardship

TVA manages the Tennessee River system and associated public lands to reduce flood damage, maintain navigation, support power production, enhance recreation, improve water quality and protect shoreline resources. TVA manages its power system to provide reliable and affordable electricity. Since 1977, TVA has spent about $6 billion on air pollution controls and is investing approximately $1 billion in more control equipment at the Gallatin

Fossil Plant in middle Tennessee. Emissions of NO_x are 91 percent below peak 1995 levels and emissions of SO_2 are 95 percent below 1977 levels through 2013.

TVA's emissions of CO_2 were reduced 32 percent between 2005 and 2013, and a 40 percent reduction in CO_2 emissions from 2005 levels is predicted by 2020. TVA is also reducing water use and waste production from its operations as it retires coal plants and increases generation from natural gas and renewable sources. Key environmental regulations relevant to TVA operations that contribute or that are expected to contribute to an overall improvement in environmental quality of air and water resources within the region include:

- Coal Combustion Residuals Rule
- Cross-State Air Pollution Rule (emissions related to SO_2 and NO_x)
- Mercury and Air Toxics Standards (Utility MACT) (emission standards for hazardous air pollutants)
- Clean Water Act Section 316(b) Cooling Water Intake Structures (entrainment and impingement reduction)
- Effluent Limitation Guidelines (levels of toxic metals in utility wastewater)

3.25.3 Analysis of Cumulative Effects

To address cumulative impacts, the existing affected environment surrounding the proposed action was considered in conjunction with the environmental impacts presented in Chapter 3. The potential for cumulative effects to each of the identified environmental resources of concern are analyzed below for Alternatives B and C.

3.25.3.1 Alterative B, Closure-in-Place

Under Alternative B, TVA will close ash impoundments in place and decisions to implement this alternative would be made on a site-specific basis. If this alternative were to be implemented programmatically at all of TVA's ash impoundments it would have very limited localized effects and those would primarily be beneficial.

As described for each resource analyzed within Chapter 3.0, resources that are not affected or that have an overall beneficial impact include land use, prime farmland, geology and seismology, floodplains, surface water, groundwater, vegetation, wildlife, aquatic ecology, threatened and endangered species, natural areas, visual and cultural resources. These resources are not included in this analysis as they are either not adversely affected, or the effects are considered to be minimal or beneficial. Overall risk related to groundwater and surface water quality would be improved on a cumulative basis within the Valley and within river systems supporting multiple coal-fired power plants subject to CCR impoundment closures (e.g., BRF and KIF on Clinch River; WCF and COF on Tennessee River; CUF and GAF on Cumberland River; Table 3-5).

This action will involve several activities that would potentially result in air, dust and noise emissions that may potentially be adverse. On-site vehicle/equipment use coupled with off-site trucking operations associated with borrow transport are the primary actions potentially affecting these resources. Construction-related traffic and transport of borrow material may result in an increase in intermittent noise at residences or other sensitive receptors located along any local roads that may be utilized during the construction period. However, emissions from these activities generally would have, a minor, short-term impact and localized effects and would not contribute to cumulative impacts.

3.25.3.2 Alternative C – Closure-by-Removal

As described for Alternative B, the overall risk related to groundwater and surface water quality would be improved under Alternative C on a cumulative basis within the Valley and within river systems supporting multiple coal-fired power plants subject to CCR impoundment closures.

As with Alternative B, the potential for cumulative effects to resources as a result of closure of ash impoundments by Closure-by-Removal is driven in-part by the need to transport CCR material to receiving landfills. This would not only impact the availability of disposal areas, but also the workforce and transportation demands associated with transporting the material and the associated off-site impacts.

Under this alternative, the amount of CCR that will have to be dewatered, excavated and hauled to permitted landfills is large ranging from 145,500 to 25,000,000 yd^3 on a site-specific basis. The volume to be transported on a programmatic basis (i.e., assuming all ash impoundments are closed under this alternative) is enormous (more than 67,000,000 yd^3). Under this alternative closure activities will also include the transport of borrow material, similar to the process discussed for Alternative B.

The quantity of dump trucks required to move this amount of material to receiving landfills is correspondingly very large and operations would be expected to result in greater effects on air emissions, GHG contribution, noise, safety and traffic operations (including roadway deterioration). Additionally, because the alternative requires significantly longer durations for impoundment closure (see Figure 3-9) the duration of operations under this alternative are long term, rather than short term. Strategies to shorten the duration of the removal effort such as increasing the number of trucks, may require utilizing resources from a wider geography range thereby expanding the scope of the cumulative effects. Additional transportation impacts may also result from overlapping haul routes extending from different plant sites to similar/different landfills. In the analysis of the closure of the hypothetical CCR impoundment in Tennessee, EPRI also evaluated the potential effects of a closure scenario similar to Alternative C. EPRI found that this scenario has a more negative impact than the in-place closure scenario when considering both $PM_{2.5}$ and PM_{10} emissions, likely due to the larger number of emission sources and the closer proximity of some emissions sources (roadways) to the residential community. Greater impacts from emissions, GHG contribution, safety and traffic operations may be expected to result in greater cumulative effects on these resources associated with this alternative.

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CHAPTER 4 – LITERATURE CITED

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CHAPTER 5 – LIST OF PREPARERS

5.1 NEPA Core Team

Name:	**Ashley Farless, PE, AICP (TVA)**
Education:	B.S. Civil Engineering
Project Role:	TVA Project Manager
Experience:	Professional Engineer and Certified Planner, 15 years in NEPA Compliance.

Name:	**Bill Elzinga (Amec Foster Wheeler)**
Education:	M.S. and B.S., Biology
Project Role:	Project Manager, NEPA Coordinator
Experience:	30 years of experience managing and performing NEPA analyses for electric utility industry and state/federal agencies; ESA compliance; CWA evaluations.

Name:	Abigail Bowen (TVA)
Education:	B.S. Environmental Science, Geography
Project Role:	TVA Waste Ash Compliance Program Manager
Experience	12 years of Environmental Compliance Experience

5.2 Other Contributors

Name	**Liz Burton (TVA)**
Education:	M.S., Wildlife and B.S. Biology
Project Role:	Terrestrial Ecology (Animals), Terrestrial Threatened and Endangered Species
Experience:	17years conducting field biology, 12 years technical writing, 8 years compliance with NEPA and ESA.

Name:	**Cathy Coffey TVA)**
Education:	BA Journalism
Project Role:	Communications Manager
Experience:	Accredited Business Communicator; 30+ years in Environmental/Public Involvement

Name:	**Adam Dattilo (TVA)**
Education:	M.S., Forestry
Project Role:	Vegetation, Threatened and Endangered Plants
Experience:	10 years botany, restoration ecology, threatened and endangered plant monitoring/surveys, invasive species control, as well as NEPA and Endangered Species Act compliance.

Name:	**Kim Pilarski-Hall (TVA)**
Education:	M.S., Geography, Minor Ecology
Project Role:	Wetlands, Natural Areas
Experience:	20 years expertise in wetland assessment, wetland monitoring, watershed assessment, wetland mitigation, restoration as well as NEPA and Clean Water Act compliance.

Name:	**Robert Marker (TVA)**
Education:	B.S., Outdoor Recreation Resources Management
Project Role:	Parks and Recreation
Experience:	40 years in outdoor recreation resources planning and management.

Name:	**Carrie C. Williamson, PE, CFM (TVA)**
Education:	M.S., Civil Engineering; B.S., Civil Engineering; Professional Engineer, Certified Floodplain Manager
Project Role:	Floodplains
Experience:	2 years in Floodplains and Flood Risk; 3 years in River Forecasting; 11 years in Compliance Monitoring

Name:	**Craig Phillips**
Education:	M.S. and B.S. Wildlife and Fisheries Science
Project Role:	Aquatic Ecology and Threatened and Endangered Species
Experience:	7 years sampling and hydrologic determination for streams and wet-weather conveyances; 5 years in environmental reviews

Name	**Karen Utt (TVA)**
Education:	JD and B.A., Biology
Project Role:	Climate Change
Experience:	21 years of experience with environmental compliance, specializes in corporate carbon risk management and climate change adaptation planning for TVA.

Name:	**Tom Waddell (TVA)**
Education:	B.S., Chemical Engineering
Project Role:	Air Quality
Experience:	30 years in air permitting and compliance, regulatory development, and air pollution research

Name:	**A. Chevales Williams (TVA)**
Education:	B.S. Environmental Engineering
Project Role:	Surface Water
Experience:	10 years of experience in water quality monitoring and compliance; 9 years in NEPA planning and environmental services.

Name:	**Richard Yarnell (TVA)**
Education:	B.S., Environmental Health
Project Role:	Cultural and Historic Resources
Experience:	39 years, cultural resource management
Name:	**Deborah Barsotti, PhD**
Education:	PhD, Pathology and B.A., Biology
Project Role:	Solid and Hazardous Waste
Experience:	30 years of experience in human health and ecological risk assessment.
Name:	**Jonathan Bourdeau (Amec Foster Wheeler)**
Education:	M.S., Mgt. Science and B.S., Forest Resources
Project Role:	Terrestrial/Wildlife
Experience:	18 years of experience in natural resources studies (protected species assessments, wetlands and NEPA).
Name:	**Karen Boulware (Amec Foster Wheeler)**
Education:	M.S., Resource Planning and B.S., Geology
Project Role:	Socioeconomics and Environmental Justice, Natural Areas, Parks and Recreation, Noise
Experience:	25 years of professional experience in NEPA.
Name:	**J. Emmett Brown, RPA**
Education:	M.A., Anthropology and B.A., Anthropology
Project Role:	Cultural Resources
Experience:	18 years of experience in development, coordination and implementation of archaeological projects.
Name:	**Kelvin Campbell (Amec Foster Wheeler)**
Education:	B.S., Geology, Geological Science and Hydrogeology
Project Role:	Geology
Experience:	25 years of experience in geology and seismic assessment.
Name:	**Steve Coates, PE (Amec Foster Wheeler)**
Education:	B.S., Civil Engineering
Project Role:	Transportation
Experience:	25 years of experience in conceptual design of urban and rural highway projects, environmental compliance and storm water management and civil site design and NEPA compliance.
Name:	**W. Kenneth Derickson (Amec Foster Wheeler)**
Education:	PhD, Biology and Ecology, M.S., Marine Biology, B.S., Biology and Natural Sciences
Project Role:	Socioeconomics, Air Quality and Climate Change
Experience:	More than 30 years of experience preparing Aquatic and Terrestrial Ecology, Land Use, Air Quality, Climate Change, Socioeconomics sections and managing the preparation NEPA documents.

Name:	**James B. Feild, PhD, RG/PG (Amec Foster Wheeler)**
Education:	PhD, Hydrogeology, M.S., Hydrogeology and B.S., Geological Oceanography
Project Role:	Groundwater
Experience:	Over 21 years of experience. Hydrogeological technical support.

Name:	**Linda Hart (Amec Foster Wheeler)**
Education:	B.S. Management/Biology
Project Role:	Technical Editor
Experience:	30 years of experience in production of large environmental documents including formatting, technical editing and assembling.

Name:	**Kenneth Paul Haywood III, FP-C, CE (Amec Foster Wheeler)**
Education:	M.S., Environmental Science and B.S., Environmental Science
Project Role:	Aquatic Ecology
Experience:	8 years of experience in aquatic, marine and terrestrial ecology studies, fisheries

Name	**Wayne Ingram P.E. (Amec Foster Wheeler)**
Education	B.S., Civil Engineering and B.S., Physics
Project Role	Surface Water, floodplains
Experience:	30 years of experience in surface water engineering and analysis including drainage, storm water management, water quality assessment, erosion and sedimentation, sediment transport, wetlands hydrology, stream restoration and storm water detention systems

Name:	**Brad Loomis, PE (Amec Foster Wheeler)**
Education:	M.S. and B.S., Civil Engineering
Project Role:	Transportation
Experience:	10 years of experience in civil engineering design including roadway and highway; storm and sanitary sewer; airport, airport facilities and site design; railroad design; federal and military facilities and permitting

Name:	**Heather Lutz, PG (Amec Foster Wheeler)**
Education:	M.S., Geological Engineering - Hydrogeology and B.S., Geology
Project Role:	Groundwater
Experience:	18 years' experience in Remediation, Investigation, Compliance, Drilling and Well Installation, Subsurface Hydrogeology, Fractured Rock Hydrogeology, Quality Assurance, Health & Safety, Waste Management and Restoration).

Name:	**Marty Marchaterre (Amec Foster Wheeler)**
Education:	JD, Law
Project Role:	Project Management
Experience:	25 years of experience in NEPA document preparation.
Name:	**Stephanie Miller (Amec Foster Wheeler)**
Education:	M.S., Biology and B.S., Marine Biology
Project Role:	Land Use and Prime Farmland, Visual Resources
Experience:	8 years of experience in visual assessment, land use, aquatic and terrestrial ecology.
Name:	**Brian Mueller (Amec Foster Wheeler)**
Education:	B.S., Fisheries Biologist/Limnologist
Project Role:	Senior GIS Analyst
Experience:	25 years in GIS applications for environmental projects.
Name:	**Lana Smith (Amec Foster Wheeler)**
Education:	M.S., Biology and B.S., Environmental Biology
Project Role:	Public Health and Safety
Experience:	21 years in Health and Safety, Hazard Analysis Assessment and Health and Safety Plan development.
Name:	**Steve Stumne, PWS**
Education:	B.S., Biology
Project Role:	Vegetation, Threatened and Endangered Species
Experience:	Over 20 years of experience providing natural resource investigations, NEPA analysis and documentation, wetland and stream delineation/permitting/mitigation and endangered species investigations
Name:	**Irene Weber (Amec Foster Wheeler)**
Education:	M.S., Biology and B.S., Plant Biology
Project Role:	Vegetation, Threatened and Endangered Species
Experience:	5 years of experience in ecology and plant biology.
Name:	**David Zopff, PE**
Education:	B.S., Chemical Engineering
Project Role:	Noise
Experience:	29 years of experience in acoustic assessments to support NEPA documentation.

CHAPTER 6 – ENVIRONMENTAL IMPACT STATEMENT RECIPIENTS

Following is a list of the agencies, organizations, and persons who have received copies of the EIS or notices of its availability with instructions on how to access the EIS on the Ash Impoundment Closure Project webpage.

6.1 Federal Agencies

Advisory Council on Historic Preservation
United States Army Corps of Engineers, Memphis District
United States Army Corps of Engineers, Mobile District
United States Army Corps of Engineers, Nashville District
United States Army Corps of Engineers, Vicksburg District
United States Department of Agriculture, Forest Service, Region 8
United States Department of Agriculture, Natural Resources Conservation Service, Alabama State Conservationist
United States Department of Agriculture, Natural Resources Conservation Service, Kentucky State Conservationist
United States Department of Agriculture, Natural Resources Conservation Service, Tennessee State Conservationist
United States Fish and Wildlife Service, Alabama, Ecological Services Field Office
United States Fish and Wildlife Service, Kentucky Ecological Services Field Office
United States Fish and Wildlife Service, Tennessee, Ecological Services Field Office

6.2 Federally Recognized Tribes

Absentee Shawnee Tribe of Oklahoma
Alabama-Quassarte Tribal Town of the Creek Nation of Oklahoma
Alabama-Coushatta Tribe of Texas
Cherokee Nation of Oklahoma
Chickasaw Nation
Choctaw Nation of Oklahoma
Coushatta Tribe of Louisiana
Eastern Band of Cherokee Indians
Eastern Shawnee Tribe of Oklahoma
Jena Band of Choctaw Indians
Kialegee Tribal Town
Mississippi Band of Choctaw Indians
Muscogee Creek Nation
Poarch Band of Creek Indians
Seminole Nation of Oklahoma
Shawnee Tribe
Thlopthlocco Tribal Town
United Keetoowah Band of Cherokee Indians in Oklahoma

6.3 State Agencies

Alabama

Alabama Department of Agriculture and Industries
Alabama Department of Conservation and Natural Resources
Alabama Department of Economic and Community Affairs

Alabama Department of Environmental Management
Alabama Department of Transportation
Alabama Historical Commission

Kentucky
Kentucky Department for Energy Development and Independence
Kentucky Department for Local Government
Kentucky Department for Natural Resources
Kentucky Energy and Environment Cabinet
Kentucky Heritage Council
Kentucky State Clearinghouse

Tennessee
Tennessee Department of Environment and Conservation, Office of Policy and Planning
Tennessee Historical Commission
Tennessee Wildlife Resources Agency

6.4 Individuals and Organizations

United States Congressional and state representatives were notified of EIS availability; local officials in our coal plant communities, all TVA local power companies and directly served customers were provided notice of the EIS availability and given briefings as requested.

Alabama
Northwest Alabama Council of Local Governments
Top of Alabama Council of Local Governments

Tennessee
East Tennessee Development District
First Tennessee Development District
Memphis Area Association of Governments
Upper Cumberland Development District

Appendix A – Comments and Response